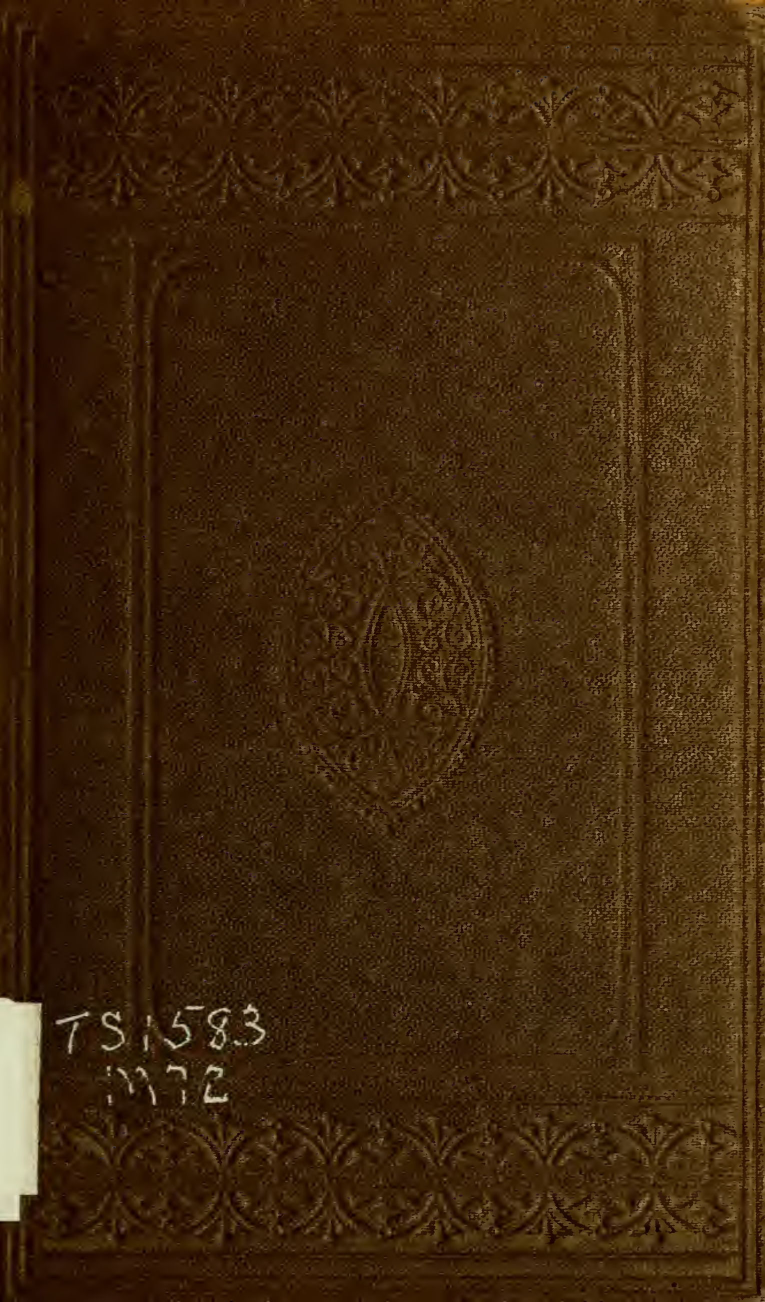

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THE
COTTON MANUFACTURERS,
MANAGERS, AND SPINNERS'
NEW POCKET GUIDE:

CONTAINING

Examples of the various Calculations

CONNECTED WITH THE

MACHINERY OF A COTTON MILL,

THROUGH ALL ITS VARIOUS OPERATIONS FROM THE
RAW MATERIAL TO THE LOOM; TOGETHER WITH
RULES WHEREBY TO FIND

The Speed of any Shaft, Drum, Spindle, or Roller

CONNECTED WITH MACHINERY.

BY JOHN MOSS.

THIRD EDITION.

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TO THE THIRD EDITION.

The two former Editions having been exhausted, the Publisher has the pleasure to announce that the work has undergone a thorough and careful revision, and much new and valuable matter has been added; the author has also given a short treatise on Decimal Fractions, in order that those readers who are not sufficiently "up" in them, may, by a little persevering application, make themselves quite familiar with every thing that is absolutely required to be known on this matter: and the Publisher flatters himself that this subject is treated in such a familiar manner, and illustrated by such easy and simple Examples, that the value of the Work is enhanced in a very considerable degree, and this invaluable portion of Arithmetic brought within the scope of the meanest capacity.

HYDE, *April* 17*th*, 1856.

Preface.

Some explanation may be necessary respecting the appearance of this little work at the present time, when it is considered that many able works, and of "larger growth," have long been before the public, containing "all the necessary calculations connected with machinery in spinning and manufacturing cotton." Under these circumstances the reader may easily imagine that, the only chance left for a new author, is to depreciate the value of those works, "to all intents and purposes," and set about exalting his own with equal assurance. Such, however, shall not be the case in the present instance; indeed, it would be folly to speak disparagingly concerning the labours of others on this subject. The strongest apology, if apology was necessary, arises from the fact of the rapid and continual progress, as well as increase of machinery, which must necessarily have a tendency to increase the demand for productions of this kind, were they even entirely devoid of originality. The next reason is, that although the body of the work may contain calculations analogous to those of most other works, yet the reader, on looking over these pages, will find examples of calculations which he will not recognise as being already *threadbare*. Believing that, along with the advancement of the age in general literature, there is also an increased thirst, in factory operatives, after the required knowledge in their respective departments,—which knowledge better enables them to discharge the responsibilities of their several situations. I have endeavoured to respond to this desire from my own conviction, as well as at the solicitation of several friends, who owned with me that there was yet more room, both in the field and the market, provided the commodity was cultivated to the taste, and brought within the reach of all. The work, such as it is, without further ceremony, I now offer to the public, whose praise or censure is the great ordeal of every undertaking, from the smallest to the largest.

J. M.

Hyde, *August 28th*, 1848.

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On Decimal Fractions.

It will be seen on examination that most of the Examples in this work are carried out decimally, where there are any fractions required. Now, believing that method of using fractions the best, and also fearing that every reader may not be sufficiently acquainted with decimal arithmetic, to derive the full advantage that the Examples are intended to give, the author has thought proper to introduce a few very plain and simple illustrations of the nature and use of *Decimal Fractions.*

A " vulgar" fraction is expressed thus : $\frac{1}{2}$; $\frac{1}{3}$; 1-6 ; 11-12 ; and read, one-half ; one-third ; one-sixth ; eleven-twelfths. The top or first figure is called the *numerator*, and the bottom or last one the *denominator;* in the last fraction 11 is the numerator and 12 the denominator. When the fractions in the solution of any questions are confined to halves, quarters, thirds, &c., there is little difficulty in their use ; but when they are more complex, as 11-12ths ; 31-35ths ; 249-367ths, and such others as often occur, it becomes difficult for the practised arithmetician to see the approximate value, and much more so the true one. I purpose, therefore, to show the reader, that with a knowledge of the first four Rules of Arithmetic, he may acquire a correct knowledge of the use of decimals. Our common notation is decimal ; take the number 321 ; let the reader examine the value of each figure in the following six several positions :—**321 ; 231 ; 123 ; 213 ; 312 ; 132 ;** and he will find that each figure is increased or diminished ten-fold, according as it is removed one place to the left, or to the right hand ; 3 in the first number where it represents 300 becomes 30 in the second and sixth, by being removed one place to the right ; and by being removed one place more to the right, as in the third and fourth, becomes 3 units. The figure 2 which represents 20 in the first and third, becomes 200 in the second and fourth by being moved one place to the left. This is the common notation which every one understands ; but why stop there ?

If we can divide 300 or 30 into ten equal parts by moving or changing the position of the figures, we can also divide 3 into ten equal parts on the same principle ; and if 300, 30, or 3,—any number whatever ; for instance, *fifteen* divided into ten equal parts gives *one and a half* for each part. Fifteen in whole numbers stands thus :—15· ; divide or diminish each of these figures tenfold, according to the principle shown above, by removing each one place to the right, in this manner, 1·5. Here I must beg the reader to notice the *dot* or " decimal point " as it is called, which is placed between the 1 and 5 ;—this is the most particular point to be noticed when using figures decimally ; indeed, if you lose sight of this point, you lose sight of the decimals. I will now place fifteen and a tenth of fifteen side by side and examine them.

In whole numbers.	Divided by 10 decimally.
15·	1·5

In each of those numbers the 5 and the 1 have the same ratio to each other; for in the number 15, as 5 is the half of 10, so in the number 1·5 the decimal ·5 is the half of 1· Again, if ·5 is the half of 1· then ·25 will represent a quarter; and ·25 × 3 = 75—three-quarters; for proof of this add these numbers together; the sum will be one.

$$\begin{array}{r} \cdot25=\frac{1}{4} \\ \cdot75=\frac{3}{4} \\ \hline 1\cdot00=1 \end{array}$$

The ciphers are of no value.

A few Examples will serve to illustrate the Rules; the first of which is

ADDITION.

Rule 1.—When a series of numbers are to be added together, consisting of decimals alone, or whole numbers and decimals, place them in such manner that the points shall be under each other.

Example 1.—Add 12·5; 10·75; 1·25; and 5·5 together.

$$\begin{array}{r} 12\cdot5 \\ 10\cdot75 \\ 1\cdot25 \\ 5\cdot5 \\ \hline 30\cdot00 \end{array} \qquad \begin{array}{r} 12\cdot50 \\ 10\cdot75 \\ 1\cdot25 \\ 5\cdot50 \\ \hline 30\cdot00 \end{array}$$

Example 2.—

Add 30·324; 24·26; 36·045; 7·405, and 7·009 together.

$$\begin{array}{r} 30\cdot324 \\ 24\cdot26 \\ 36\cdot045 \\ 7\cdot405 \\ 7\cdot009 \\ \hline 105\cdot043 \end{array}$$

The same Rule applies to SUBTRACTION.

Example 3.—Subtract 7·25 from 10·5.

$$\begin{array}{r} 10\cdot5 \\ 7\cdot25 \\ \hline 3\cdot25 \end{array}$$

—7¼ from 10½ leaves 3¼.

Example 4.—Subtract 1·75 from 10.

10·
1·75

8·25—$1\frac{3}{4}$ from 10· leaves $8\frac{1}{4}$.

Example 5.—Subtract 1·125 from 3·25.

3·25
1·125

2·125—$1\frac{1}{8}$ from $3\frac{1}{4}$ leaves $2\frac{1}{8}$.

MULTIPLICATION

Is precisely similar to that of common numbers, but applying these Rules to the product.

Rule 2.—Point off as many figures in the product, towards the right hand, for decimals, as are contained in the multiplier and multiplicand together.

Example 6.—Multiply 7·25 by 10·5, and 20·5 by ·125.

7·25	20·5
10·5	·125
3625	1025
7250	410
	205
76·125	2·5625

Rule 3.—If the product do not contain as many figures as are in the two numbers multiplied, prefix so many ciphers as make up the number of places.

Example 7.—Multiply ·123 by ·125.

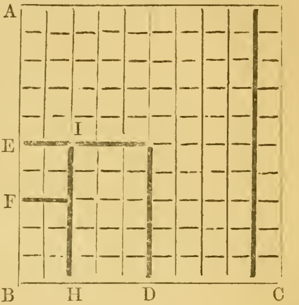
·123
·125

615
246
123

·015375

Ex. 8.—Multiply ·045 by ·105.	Ex. 9.—Multiply ·525 by ·005.
·105	·005
225	·002625
0450	
·004725	

It may perhaps puzzle a learner to account for the fact that the multiplication of two fractions gives a product which is less than either, numerically. I will endeavour to make this as plain as possible. Any number, either whole or fractional, may be supposed to be represented by a straight line, and the *product* of two numbers by a square or parallelogram, just as the product is that of a number multiplied by itself, or of two unequal ones.



Let the reader draw a line A B. and another B C, forming the two sides of a square; divide each into ten equal parts, and draw lines from the points of division parallel to the other sides; he will then have a square representing the product of a line (or number) multiplied by itself. In the first place, suppose the line A B to represent 1· and then each division will be 1-10th, or ·1; three divisions ·3; five divisions ·5, &c.; let the line E B be multiplied by B D, or ·5 by ·5, the product is ·25, or $\frac{1}{4}$; on looking at the square it will be found so, and is read twenty-five-hundredths. Multiply F B by B H, ·3 by ·2, the result is ·06 or ·6-hundredths; E B by B H, ·5 by ·2 = 10-hundredths, or ·1-tenth. By counting the small squares in the figure to which these numbers apply and also of others which he may try, the reader can verify the products of many small fractions for himself; and by constructing a figure with its sides divided into 100 or 1000 parts, he may study both with pleasure and advantage the relative value of a variety of decimal fractions.

DIVISION

Is also performed in a similar way to that of ordinary numbers, the only difficulty being to *value* the quotient: that is to find where the decimal *point* in the quotient should be placed. To divide any whole number by a smaller whole number, as 360 by 2, 4, 6, 10, or 12, is in itself simple and comprehensible; it is a practical matter; it may be made a rule and compass question; but when we come to divide a number or given quantity by a fraction, such, $\frac{1}{4}$ ·25; $\frac{1}{2}$ ·5; $\frac{3}{4}$ ·75, ·05, &c., we have then to perform an operation which is only comprehensible on arithmetical principles. If we divide 20· by 5· the result is 4·; but if we divide 20· by ·5, the quotient is 40·; we shall find however, that the quotients 4· and 40· have an exact, although, inverse ratio to the divisors; the quotient 40· is ten times as great as the quotient 4· because its divisor (·5) is ten times less than the first divisor (5·). Therefore the operation of dividing a less number by a greater, a whole number by a fraction, or one fraction by another, is not *division* in the proper sense of that term; it is the finding of a *ratio* between the two numbers; but is commonly called so, because the arithmetical process is the same. The Rules to be guided by in division are as follow:

Rule 4.—Proceed as in common division, and when finished, place the decimal point so that there may be as many decimals in the divisor and quotients together, as there are in the dividend.

Example 10.—Divide 52·8125 by 8·45.

8·45)52·8125(6·25 quotient.
50 70
2112
1690
4225
4225

To the uninitiated this *Rule* will seem deficient, for on looking over the solutions in this work, many quotients will be found to have more decimals than the number to be divided, and some less than the Rule would seem to require. The reader must have a little more explanation which shall be given, with very easy Examples.

Suppose you wish to divide 10· by 4· and 20· by 8·

Example 11.—4)10· 	Example 12.—8)20
2·5 	2·5

Here the quotient in each case is 2·5 (or $2\frac{1}{2}$), yet there are no decimals in the dividend; but you may suppose or imagine there are, in the shape of ciphers, to which you always carry the remainder; thus, 4's in 10=2 and 2 over, which 2 you carry as in common division to an imaginary cipher on the right of the dot or *point;* and this process may be continued as long as there is any remainder.

Example 13.—8)10· 	Ex. 14.—8)17
1·25 = $1\frac{1}{4}$ 	2·125 = $2\frac{1}{8}$

Again, suppose you divide 10 by 1·25, and 17 by 2·125.

Example 15.—1·25)10·00(8 	Ex. 16.—2·125)17·000(8
1000 	17000

Hence the following Rule may be deduced.

Rule 5.—If the Dividend have not any, or so many decimals as the divisor, add ciphers to make up the deficiency; and if there be a remainder still, add ciphers at pleasure.

Example 17.—12 divided by 3·1416 = 3·81*
Example 18.—22 ,, ,, 3·1416 = 7·
Example 19.—97·3 ,, ,, 12·1625 = 8·
Example 20.—24·8 ,, ,, 1·225 = 20·

* See also Examples 2nd and 5th, Carding Engine.

Suppose you wish to divide 8· by 10· or 20· by 25· ; here the divisor is greater than the dividend; the quotient must therefore be a fraction. If you suppose the 8 to be converted into tenths, you then have *eighty-tenths ;* this divided by 10 gives eight-tenths or ·8; also, 200 tenths divided by 25 gives eight-tenths; place them in this manner.

10)8·0(·8 25)200(.8
80 200

And if the divisor is greater than the dividend, in *tenths*, convert it into hundredths (by adding another cipher) and so on as long as is necessary. Hence this Rule which is nearly similar to Rule 5.

Rule 6.—If the divisor be greater than the dividend, add ciphers to the latter, until the quotient (will go) is contained in it.

Ex. 21.—20 divided by 40 = ·5 100 ÷ by 125 = ·8
Ex. 22.—20 ,, ,, 50 = ·4 40 ÷ ,, 50 = ·98
Ex. 23.— 2 ,, ,, 40 = ·05 110 ÷ ,, 111 = ·990
Ex. 24.— 1 ,, ,, 40 = ·025 3·1416 ÷ ,, 4 = ·7854

See also Example 1st, Carding Engine.

Rule 7.—When the divisor is entirely of decimals the quotient will be whole numbers until as many decimals or ciphers have been added, or brought down on the right of the dividend as there are figures in the divisor.

Example 29.—100 divided by ·25 = 400
Example 30.—100 ,, ,, ·125 = 800

See Ex. 17,—Sharpe's Self-Acting Mules; and Ex. 8. Smith's do.

The reader may now be supposed to have acquired some notion of the nature of decimal fractions; that they are nothing more than parts of Unity, carried out by the common notation to tenths, hundredths, thousandths, &c., and being distinguished by the *point* where unity terminates.

I will now show the learner how to read them; how to convert vulgar into decimal fractions; how to convert other quantities (such as inches, feet, &c.; ounces, pounds, &c.) into decimals of a greater denomination; and, lastly, how to value a decimal fraction, which, in a practical point of view, are the principal things required to be known.

In the first place turn to the figure in Section Multiplication, and take the small square E D, which is one-fourth of the whole; let this simple vulgar fraction be taken, to convert into its equivalent decimal; this $\frac{1}{4}$ is simply unity, or one required to be divided by four; let that process be performed according to Rule 6th; thus:

$$\begin{array}{r} 4)\,1\cdot \\ \hline \cdot 25 \end{array}$$

The result is commonly read or expressed 4, "decimal (25) twenty-five," but more properly "twenty-five hundredths;" because the division of the 1) has been accomplished by imagining it to have been converted into *one* (100) *hundred* parts, 25 of which are one-fourth. The learner may count the small squares in the figure E D and satisfy himself of the truth of this. A decimal fraction may therefore be read as a vulgar fraction, having for its denominator, Unity, or 1 with as many ciphers as there are figures in the numerator; $\frac{1}{2}$=·5, read 5-10ths; $\frac{3}{4}$=·75, read 75-100ths; $\frac{1}{8}$=·125, read 125-thousandths.

Example 31.—1-20th=·05, read 5-100ths.

Example 32.—1-25th=·04, „ 4-100ths.

Example 33.—1-40th=·025, „ 25-1000ths.

Example 34.—75-200ths=·375, read 375-1000ths.

Example 35.—25-75ths =·333 to infinity, and may be read 1-3rd, 3-9ths, or 333-999.

TO CONVERT MIXED NUMBERS INTO DECIMALS.

It is to be regretted that the decimal system has not been adopted long ago, both in money, weight, and measures; the calculations in all our business transactions would thereby be simplified very considerably. If there were an Unit of value for money, as £1; of measure, as 1 foot; of weight, as 1 pound; or such other unit as might be easily divisible into tenths, hundredths, &c., the application of decimals to these, as well as to common numbers, would become a matter of ease and facility; but with our present complex system of "Denominations," there is really, to a learner, considerable difficulty.

By the word "denominations" is meant the separate figures or quantities specified in each of these compound numbers, 2ft. 3 inches;—1℔. 6oz. 5dr.;—£2 15s. 7$\frac{3}{4}$d. In the last there are four "denominations,"—farthings, pence, shillings, and £'s. To reduce to decimals any such compound number, observe the following very simple rules.

Rule 8.—Divide the lesser denomination by the number of itself, which are contained in the greater denomination.

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Ex. 36.—3 inches reduced to the decimal of 1 foot =·25
Ex. 37.—6 oz. ,, ,, ,, 1 pound=·375
Ex. 38.—5 dr. ,, ,, ,, 1 oz. =·3135
Ex. 39.—15s. ,, ,, ,, 1 £. =·75
Ex. 40.—$\frac{3}{4}$d. ,, ,, ,, 1d. =·75

Observe, these are the decimals of each separate denomination; to reduce a mixed number to the decimal of any higher denomination; the following is the Rule:

Rule 9.—To the decimal of the lowest denomination found as above, prefix on the left the next denomination as a whole number, and divide again, by the number in the next higher denomination.

Example 41.—Reduce 1s. 3d. to the decimal of £1.

12)3	20)1·25(·0625=1s. 3d.
—	1 20
·25	50
	40
	——
	100
	100* usually wrote thus, £·0625

To reduce a decimal to its value in mixed quantities, observe the following Rule:

Rule 10.—Multiply by the next lower denomination, pointing off as many places to the right as there are at first, and continue this process until the lowest denomination is brought out.

Example 42.—Reduce £·6125 and £·7245 to their equivalents in money.

·6125	·7245
20	20
12·2500	14·4900
12	12
3·0000=12s. 3d.	5·8800
	8
	7·0400=14s. 5$\frac{7}{8}$d.

Reduce ·6575 feet and ·6575 yards to their equivalents.

·6575	·6575
12	3
7·8900	1·9725
8	12
7·1200=7$\frac{7}{8}$ inches. An.	11·6700
	8
	5·3600=1ft. 11$\frac{3}{8}$inches.

---

* There are four decimals used in the dividend; hence there are four in the quotient, therefore the cipher must be prefixed to the 625.

Calculations of Speeds, &c.

General Rule for finding the speed of any shaft, wheel, pulley, or other rotary moving body.

Multiply the speed of the first shaft, wheel, or pulley by all the driving shafts, wheels, or pullies successively, and divide the product by that of all the driven shafts, wheels, or pullies; the quotient will be the speed of the last shaft, wheel, or pulley.

Example. *Find the speed of the first upright shaft.*

Suppose the Steam Engine makes 22 strokes per minute with a wheel of 120 teeth on the crank shaft, working into a pinion, on the first or main shaft, of 60 teeth, on the same shaft is a wheel of 96 teeth driving a wheel on the upright shaft of 48 teeth.

```
  60               22  strokes of engine.
  48              120
  —               ———
 480             2640
240                96
———              ————
2880            15840
               23760
               —————
          2880)253440(88  revols. of upright shaft.
               23040
               —————
                23040
                23040
```

See example 2nd under the head carding engine, as another illustration.

For the sake of the Tyro, it may be necessary to observe that in the calculations of wheels the *number* of teeth is always used, being equivalent to the circumference; with pullies, the diameters may be used, even with wheels, on the principle that the diameters and circumferences of circles are proportional to each other.

General Rule for finding a wheel, drum, or pulley, necessary to produce a required speed.

Multiply the speed of the driving wheel, drum, or pulley, by the intermediate driving wheels, drums, or pullies, (if any) for a divisor; and multiply the required speed by the intermediate driven wheels, drums, or pullies, for a dividend, the quotient will be the wheel, drum, or pulley required.

Example. Suppose the main shaft revolves 48 times per minute, and it is required to make the upright shaft revolve 96 per minute, having a wheel of 48 teeth; what wheel must the main shaft have on.

48 divisor

96 required revols. of upright
48

768
384

48)4608(96 wheel required
432

288
288

Example 2nd. Suppose it were required to drive the twist shaft of a mule at the speed of 280 revolutions per minute, the principal horizontal shaft making 144 revolutions, having a drum of 20 inches diameter, which drives a counter pulley 14 inches, on the same counter shaft is the required pulley, which drives the fast pulley on the twist shaft, 12 inches. What diameter is the counter driving pulley.

144
20

2880

280 required revolutions
12

3360
14

13440
3360

2880)47040(16.3 or 16⅓ inches
2880

18240
17280

9600
8640

960

Carding Engine.

Suppose a shaft be making 90 revolutions per min.; having a drum of 16-in. diam. driving the pulley 12-in. on the main cylinder shaft of a Carding Engine. Required the speed of the main cylinder.

90 revols. per min.
16
12)1440

120 speed of main cyl.

From the following particulars of the Carding Engine find the respective speeds, draught, &c.

main cyl.	120 revols. per min.	
ditto pinion	14 teeth.	driving
1st stud wheel	96 ,,	on the axis of which is
a pinion of	34 ,,	driving
2nd stud wheel	96 ,,	on the axis of which is
a pinion of	20 ,,	driving
feed roller wheel	128 ,,	
feed rollers	1½ in. diam.	
doffing cylinder	17 in. diam.;	on the end of which is
a wheel of	127 teeth	driven by
a pinion of	50 ,,	on the same stud is
a wheel of	120 ,,	driven by the main cyl. pinion

Example 1st.—To find the revolutions of feed rol. per min.

96	14 main cyl. pin.
96	34 1st stud pin.
576	56
864	42
9216	476
128	20 2nd stud pin.
73728	9520
110592	120 m. cyl. revols. per m.
1179648	1142400

[*Carried forward.*

EXAMPLE 1st CONTINUED.

```
Divisor  1179648)1142400·(·9684 revol. of feed rol.
                 10616832             per min.
                 --------
                  8071680
                  7077888
                  -------
                   9937920
                   9437184
                   -------
                    5007360
                    4718592
                    -------
                     288768
```

On a little consideration it will be seen that this question can be solved by finding the number of revolutions of the Main Cylinder, for the feed roller one; and then dividing the revolutions per minute, of the Main Cylinder, by that number, which would give the same result.—But as this method would involve two operations, the following more simple *Rule* is given. Multiply the driving wheels together and their product by the revolutions of the first wheel, for a dividend; and Multiply the driven wheels for a divisor. The quotient will be the revolutions *per min.* of the last wheel.

EXAMPLE 2nd.—Required the revolutions of the Doffing Cylinder per min.

```
   120              14
    120              50
   ----             ---
  14400             700
                    120
                    ---
          14400)84000(5·83  revols. per min.
                72000            of doff. cyl.
                ------
                120000
                115200
                ------
                  48000
                  43200
                  -----
                   4800
```

DRAUGHT OF CARDING ENGINE.

CASE 1st.—When the feed rollers are connected with the Doffer by a long driver.

RULE 1st.—Divide the product of the feed roller wheel and diameter of Doffer, by the product of the pinion on the long driver and diam. of the feed roller: the result will be the draught.

EXAMPLE 3rd.—

```
diam. of feed rol.   1¼ in.        18 in. diam. of doff. cyl.
pin. on long driver  16            80     wheel on feed rol.
                     —             —
                     20          1440(72 draught
                                 140
                                 ———
                                   40
                                   40
```

RULE 2ND. Multiply the driving wheels on the end of doffer and side shaft together with diameter of feed roller, for a divisor; and likewise the driven wheels on feed roller and side shaft, together with diameter of doffer for a dividend. The quotient will be the draught.

EXAMPLE 4TH. Suppose there is a 24 bevil wheel on the doffer driving a 32 on the side shaft; a 16 pinion on the other end of side shaft, driving a 60 on feed rollers; what will be the draught?

```
       24                     60 feed rol. wheel
       16                     32
      ———                    ———
      144                     120
      24                     180
      ———                    ———
   ¼  384                    1920
       1¼                      18
      ———                    ———
      384                    1536
       96                    192
      ———                    ———
      480               48|0)3456|0(72  draught
                          336
                          ———
                             96
                             96
```

To find a bevil pinion that will produce a required draught, having the other wheels, &c. given, substitute *draught* for *pinion* in the preceding Rule; Example 4th.

```
        24                          60
        72                          32
       ———                         ———
        48                        1920
      168                           18
       ———                         ———
      1728                        1536
         1¼                       192
       ———                         ———
      1728                  216|0)3456|0(16 pinion
       432                        216
       ———                         ———
      2160                        1296
                                  1296
```

Case 2nd.—When the feed rollers are driven by wheel and pinion from the Main Cylinder; in this case, suppose the motion to commence with the feed roller; and consider the feed roller wheel the first driver, then we shall have the following simple rule.

Rule:—Multiply all the drivers, or leaders together, and the diameter of doffing Cylinder, for a dividend; and all the driven, or followers, and diameter af feed roller for a divisor. The quotient will be the draught of the Engine.

Example 5th.—From the foregoing particulars of a Carding Engine find the draught.

ollowers 20	Leaders 128	34	128
34	96	20	96
14*	96		
120	14*	680	12288
120	50	120	96
Feed rol. 1½	17 diam. of doff.		
		81600	1179648
		120	50
		½)9792000	58982400
		4896000	17
		14688000	1002700800

Example 5th continued.

146880|00)10027008|00(68,266 draught.
881280

1214208
1175040

391680
293760

979200
881280

979200
881280

97920

*Note.—Similar terms in each group may be omitted: the process may also be shortened by dividing any two terms in each group, by any number which will divide both without remainder. Thus—

CONTINUED.

Followers	Leaders
5	32
•17	8
10	8
10	25
1½	17•
again	
1	32
10	8
10	8
3	1

10
10
—
100
·3
—
30.

32
8
—
256
8
—
2048(68.266
180
—
248
240
—
80
60
—
200
180
—
200
180
—
20

EXAMPLE 6TH.—Required the diameter of the cálender, or delivery rollers, from the following particulars.

diam. of doff. cyl.	17	inches
wheel on „ „ end	120	teeth
wheel on delivery rol.	25	„

Then as 120 : 17 in. : : 25 : 3.54 inches
25
17
—
175
25
—
120)425(3,54
360
—
65·0
600
—
5·00
480
—
20

Carding Engines are now generally made with a "licker-in;" a roller or cylinder which takes the cotton from the feed rollers, and which, until lately, was usually covered with common fillet cards; this, however, soon becomes felted with the short fibres which the main cylinder cannot clear off, rendering it necessary for this "licker-in" to be taken out and ground oftener than otherwise would be required, for if the wire becomes "hooked" the evil is increased; this difficulty has been in a great measure obviated by the "pin point" cards, and more perfectly so by the "saw tooth" licker-in; which are always clear so long as the points and teeth are not injured by "rubbing," or some hard substance passing through.

The most perfect carding engine perhaps hitherto made, is that patented by Evan Leigh, of Miles Platting; in which the regularity of the carding,—where there is a considerable interval between stripping,—is nearly got rid of by a system of moving flats, which are constantly being stripped by a self-acting movement, and which are so arranged as to put more carding in than any number of rollers can. These cards are adapted to suit almost any quality of work, and although rather complicated, are decidedly a step in advance.

The Double Carding Engine.

In some parts of Lancashire double carding engines are prevalent; they are well adapted for low numbers, as they turn off a deal of work.

These engines have two main cylinders, one "slow tummer," and one doffing cylinder; the slow tummer is between the main cylinders; its diameter is less than that of the main cylinder, and from one end of this *tummer* the feed rollers are generally driven by a side shaft, similar to case 1st, single carding engine. The cylinders are surmounted by rollers and clearers upon the most approved principle; and the amount of carding given to the cotton may be equal to the carding of the Breaker and Finisher of the single carding engines; or, it may be more or less, at the discretion of the carding-master. The main cylinders are generally driven at the same speed, by means of a belt from one to the other, and have also equal diameters.

These engines have been in operation for thirty-four years back in Oldham and its neighbourhood, with great satisfaction.

The following are the dimensions and data for finding the draught, and also the speeds of different parts of the engine:—

	Inches.	Teeth.	
Feed roller	2		
Slow Tummer	28		
Driving wheel on back cyl.	8½		
Driving pulley	17½		
Wheel on pulley		60	driving
Slow Tummer wheel		180	
Bevil wheel on slow Tum.		32	driving
Do. side shaft		56	
Pinion on do.		21	driving
Feed roller wheel		136	
Pulley on front cylinder	8½		
Driven pulley	27½		
Wheel on pulley		50	driving
Wheel on doffer		180	
Diameter of doffer	22		
Do. of front cylinder	38		
Draw Box			
Front roller	2		
Back do.	1¾		
Front roller wheel		21	
Back do. do.		31	
Wheel driving front roller		26	
Do. back roller		26	
Pinion wheel		19	

Revolutions of main cylinder, 120 per min.

[*Carried forward*

Continued.

From the above data find the draught of the double Carding Engine.

Rule 1st. Multiply the driving bevil wheels on slow tummer and side shaft, and diameter of feed roller together for a divisor; and likewise driven wheels on side shaft and feed roller together with diameter of doffer for a dividend; also, take the wheels in connection with slow tummer into the divisor, and those in connection with doffer into the dividend. The quotient will be the draught of the engine.

Example 1st.

32	136 feed rol. wheel.
21	56
32	816
64	680
672	7616
2	22
1344	15232
60	15232
80640	167552
180 *	50
64512	8377600
8064	180
145152|00	670208
	83776

145152|60)15079680|00(103·8
145152 draught
564480
435456
1290240
1161216
129024

Note.—* See Example 5th, page 18.

Example 2nd. From the above data find the speed of the feed rollers per minute.

Rule. Multiply the driven wheels together for a divisor; and also the speed of main cylinder and driving wheels for a dividend. The quotient will be the speed of the feed rollers.

[*Carried forward.*

CONTINUED.

```
EXAMPLE.   180                   120  revols. of main cyl.
            56                    60
          ----                  ----
          1080                  7200
          900                   32
          ----                  ----
         10080                  14400
           136                 216
        ------                 ------
         60480                 230400
        3024                       21
       1008                    ------
       -------                 230400
       1370880                4608
                              -------
                137088|0)483840|0(3·5 or 3½ revols. per m.
                          411264
                          ------
                           725760
                           685440
                           ------
                            40320
```

From the same data find the revolutions of doffing cylinder per minute.

```
Doffing wheel 180           120  revols. of main cylinder.
                              50
                            ----
                      180)6000(33·3
                          540
                          ----
                           600
                           540
                           ----
                            60·0
                            540
                            ----
                             60
```

To find the velocity of feed rollers, and also of the doffing cylinder, apply the following:

RULE. Multiply the respective diameters by the number, 3·1416, and that product by revolutions per minute. The last product is the velocity per min.

[*Carried forward.*

CONTINUED.

EXAMPLE 1ST. 3·1416 { Circumference of a circle

2 { when diameter is unity.

6·2832

3·53 revols. of feed rol. per min.

188496

344160

188496

22·179696 velocity of feed rol. in inches

EXAMPLE 2ND. 3.1416

22 diameter of doff. cylinder

62832

62832

69·1152

33·33 revols. of doff. cyl. per min.

2073456

5073456

2073456

2073456

2303·609616 velocity of doffing per minute

To find the draught of the Engine from these two velocities, observe the following :—

RULE. Divide the velocity of doffing cylinder by that of the feed roller. The quotient will be the draught.

EXAMPLE. 22·179696)2303·609616(103·8 draught

2217·9696

85640016

66539088

19100928·0

177437568

13571712

Continued.

Find the draught of the draw box from the preceding data.

Diam. 1·75 back rol.	2 diam. front rol.
21	31
175	36·75)62·00(1·68 draught of box
350	3675
36·75	25250
	22050
	32000
	29400
	2600

Find the whole draught of the Engine from the two draughts found above.

103.8 draught between feed rol. and doff.
1·68 do. draw box
8304
6228
1038
174·384 whole draught.

To find the whole draught at one operation.

32	136 feed rol. wheel
21	56
672	7616
2	22
1344	167552
60	50
80640	8377600
1·75	2
141120·00	16755200
21	31
2963520·00	)519411200(175·3 draught
	2963520
	22305920
	20744640
	15612800
	14817600
	795200

To find the counts of the sliver from the Carding Engine.

Rule.—The product of the draught and the length on which the given weight is spread, divided by the product of the length of an Hank, and the given weight will give the counts of the sliver.

Example.—Suppose there are 20 oz. of cotton on 36 in. at the double carding engine, what is the size of the end with the foregoing draught?

840 yds. in 1 hank.
$1\frac{1}{4}$=20 oz.

840
210=$\frac{1}{4}$

1050

1050)175·3(·166 or about one-sixth of an hank.
1050

7030
6300

7300
6300

1000

Sliver Lap Machine.

The unevenness to which Breaker Carding is liable, on several accounts, has given rise to another lap machine, which when carried out, to its ultimate object will supersede the old "tummer" plan of 8 feet laps most decidedly. This machine occupies little room; and runs up from the breaker cans, a number of ends corresponding to the draught of the finisher card. By means of an indicator connected with the feed rollers, a definite length can be put on the lap roller, which when weighed, may be regulated to any exactness required.

Suppose there are 10 oz. of cotton on 36 in. at the breaker card, and a draught of 68; required the weight of finisher lap, the length being 70 yds. and the number of ends 34.

```
68 draught          70
                    34
                    —
                   280
                  210
                 ————
              68)2380(        35
                  204         10
                  ———         ——lb.  oz.
                  340     16)350(21  14 weight of lap
                  340         32
                              —
                              30
                              16
                              —
                              14
```

If there be 10 oz. per 36 in. at the breaker, a draught of 68; 34 ends put up for a finisher lap, and its weight 21 lb. 14 oz.; what is the length of the lap?

```
           oz.     yd.      lb.     oz.
        As 10  :   1   ::   21   :  14
           34               16
           —                —
          340              350
                            68
                          —————
                     340)23800(70 yds.
```

Suppose there is a loss of 1 oz. per lb. at the breaker card and 10 oz. are spread on 36 in.; what number of ends must be put up at the doubling lap machine, so that the finisher may have a lap of 10 oz. per 36 in.

The loss is in the proportion of one-sixteenth, therefore we must divide the number of ends by 16, and add the quotient to the original number, which will give the number of ends required.

```
Thus   16)68(4·25          68
          64                4·25
          —                 —
           40               72·25 No. of ends.
           32
            —
            80
            80
```

Drawing Frame.

The Drawing Frame which is generally adopted now, consists of a single beam having four "*rows*" of rollers; there is a draught between each two "*rows*," consequently three draughts are obtained by this plan. Besides this advantage the draughts can be proportioned, so as to produce the intended effect with the most perfect regularity.

Where two beams are adopted, the same number of rollers are necessary for only two draughts. And if six ends are put up, the two draughts must be upwards of six, consequently one of the draughts must be three at least.

NOTE.—For convenience I will call the front ROW the 1st, and the next ROW the 2nd, &c.; the back rollers being the 4th ROW.

The following are the particulars of a Drawing Frame.

wheel on front rol.	32	driving	driving end.
wheel on stud	72		
pinion on do.	28	driving	
wheel on back rol.	66		
front rol. 1¼ or	1·25 in diam.		
back and mid. do.	1 ,,		
wheel on front rol.	14	driving	opposite end.
wheel on 2nd row	28		
back rol. wheel	22		
wheel on 3rd row	14		

Required the whole draught of the Drawing Frame.

RULE 1st.—Divide the product of the driven wheels, and diam. of front roller, by the product of the driving wheels and diam. of back roller; the quotient will be the total draught.

EXAMPLE 1st.	drivers.	driven.
	32	72
	28	66
	—	—
	256	432
	64	432·
	—	—
	896	4752

```
        4572
         1·25
        ————
       22860
       9144
      4572
       ————
  896)5715·00(6.37
      5376
      ————
        3390
        2688
        ————
          7020
          6272
          ————
            748
```

Case 2nd.—To find the draught between the back rollers and third row, or 2nd middle.

Rule 2nd.—Divide the back rol. wheel by the wheel on the third row; the quotient will be their draught.

```
Example 2nd.    14)22(1·5714 call this the first draught
                   14
                   —
                    80
                    70
                    —
                    100
                     98
                     —
                      20
                      14
                      —
                       60
                       56
                       —
                        4
```

Case 3rd.—To find the draught between the front rol. and 2nd row; or 1st middle.

Rule 3rd.—Multiply the diam. of front rol. by wheel on 1st middle and divide by the front wheel; the quotient is their draught.

```
    front rol. pin. 14      1·25
                             28
                           ————
                           1000
                           250
                      14)35·00(2·5   3rd draught
                           28
                           —
```

There is also a draught between the two middle rows of rollers; which will be found by the following.

Rule 4th.—Divide the total draught by the product of the 1st and 3rd draughts; the quotient will be the mid. draught.

Example 4th.

1·5714=1st drgt.
25=3rd drgt.
78570
31428
3·92850

3·9285)6·6294(1·687 2nd or middle draught.
39285
270090
235710
343800
314280
295200
274995
20205

Any of the draughts may be found by dividing the "speed" of the quicker roller by the other.

To find how many revolutions per min. the front rols. make.

Rule 5th.—Multiply the revolutions of driving shaft, by the diam. of driving drum, and divide the product by the diam. of driven pulley; the quotient will be the revols. per min.

Example 5th.

diam. of pulley 7 in.
96 revols. of shaft per min.
20 diam. of drum.
7)1920
274·2857 revols. of front rol. pr. min.

Example 6th.—Required the speed of the 2nd row, or 1st mid. rol. per min.

wheel on mid. 28
274·2857
14
10971428
2742857
28)3839998(137·14285
28
103
84
199
196

It would be useless to increase the bulk of the work, by working every question in full, when they are so simple.

Carried forward.

Continued.

39
28

119
112

79
56

238
224
140
140

Example 7th.—Required the speed of back rollers per min.

72 } driven
66 }

432
432

4752

revols. of front rol.
274·2857
896

16457142
24685713
21942856

32 } drivers
28 }

256
64

896

4752)245759·9972(51·7171 revol. pre min.

Example 8th.—Required the speed of the 3rd row or 2nd mid. rol. per min.

wheel on 2nd mid. 14 51·7171 speed of back rol.
22 wheel on do.

1034342
1034342

14)1137·7762(81·2697 speed of 2nd mid.

Example 9th.—Required the middle draught, from the speed of mid. rollers.

speed of 1st middle.
81·2697)137·14285(1·687 draught between
812697

5587315
4876182

7111330
6501576

6097540
5688879

408661

Example 10th.—Suppose it were required to change the draught
pin.
from 6·6 to 8, then by proportion, as 8 · 6·6 : : 28 : 23 pinion required.

6·6
28
528
132
8)184·8
23· pinion

Example 11th.—Suppose it were required to change the draught from 6·6 to 4·2, then by proportion 4·2 : 6·6 : : 28 : 44.

thus 6·6
28
528
132
4·2)184·8(44 pinion required
168
168
168

In this case the middle draught will be less than the back draught; and requires altering if they must increase successively.

Suppose we make the first draught 1·3 and the third draught 2; what will be the middle draught?

1·3
2
2·6

2·6)4·2(1·615 middle draught
26
160
156
40
26
140
130
10

If the front roller be 1.25 in. diam. and has on a 15; what must the 2nd rol. have on, to produce a draught of 2?

Rule.—Multiply the wheel on front rol. by the draught required, and diam. of mid. rol.; divide the product by the diam, of front rol.; and the quotient will be the wheel required.

EXAMPLE 12th. 15
2

1·25)30·0(24 pin. required.
250

500
500

There are most commonly three "heads of drawing," but as the calculations are the same, they need not be particularized.

There is also the "old" drawing frame with two beams, but as they are now generally superseded by the forementioned drawing frames, I shall omit their calculations.

Slubbing and Roving Frame.

These are the most complicated machines in the mill, not excepting the self-acting mule; they are both made on the same principle, and are similarly constructed, but adapted to different stages of the work; the former producing a preparation for the Roving Frame, and the latter a preparation for the mule or throstle.

There is no machine which has undergone so many improvements, indeed there are few of so much importance, as the Roving Frame. Various machines have been constructed, and brought into practice, under different names; the most successful being those which produce the best work in the greatest quantity. Some are, however, better adapted to the production of the finer counts, while others seem to have the advantage in the coarser; in this respect Dyer's Patent Tube Frame has acquired considerable popularity, being capable of producing a great amount of work when the roving is from four hank downwards; another advantage, considered by some, is this, the rove in passing through the tube is much compressed, yet having no twist, which makes it more easily drawn in the spinning. But the Frame most generally adopted, is that known popularly, as "The Patent Fly Frame." The limits of this work do not allow of a description in full; I shall, therefore, content myself with giving the principal calculations.

Required the draught of the Roving, or "Jack Frame," from these particulars.

wheel on front rollers	28 teeth	driving
wheel on stud	72 ,,	
pinion on do.	22 ,,	driving
wheel on back roller	52 ,,	
diameter of front roller	1¼ inch	
diameter of back roller	1 ,,	

Rule.—Multiply the driving wheels, and diameter of back roller for a divisor; and likewise the driven wheels with diameter of front roller for a dividend; the quotient will be the draught of the frame.

front rol. wheel	28	52	back rol. wheel
stud pinion	22	72	
	56	104	
	56	364	
	616	3744	
		1¼	
		3744	

3744
936=¼

616)4680(7½ draught
4312

368

Example 2nd. Required the speed of front rollers from the following data.

driving shaft	130	revolutions	per min.
drum on do.	22	inches	diameter
frame pulleys	10	,,	,,
wheel on 1st propelled shaft	22	teeth	driving
wheel on shaft under rollers	60	,,	
wheel of	100	,,	driving
front roller wheel	110	,,	

110 130 revols. of driving shaft.
60 22

6600 260
10 260

Divisor 66000 2860
22

5720
5720

62920
100

66|000)6292|000)95·333 revols. of front rol. per min.
594

352
330

220
198

220
198

220
198

22

Example 3rd.—Required the speed of back rollers per minute.

```
       72               95·333
       52                  28
      ——               ———————
      444              762664
     360              190666
     ————             ———————
     3744             2669·324
                           22
                      ————————
                      5338648
                     5338648
                     —————————
            3744)58725·128(15·685 revols. of back rol.
```

Find the speed of first propelled shaft, from the data in Example 2nd.

```
          Divisor 10        130
                             22
                            ———
                            260
                           360
                           ————
                        16)2860
                           ————
                        286 revols. of frame shaft per min.
```

Example 4th.—Required the number of inches traversed by the front rol. per min.

```
        3·1416 circumference of a circle when diam. is 1
          1·25 diam. of front roller
        ——————
        157080
        62832
       31416
       ——————
       3·927000
       95·33   revols. of front roller
      ——————
      11781
     11781
    19635
   35343
   —————
   374·36091 inches per min. traversed by front roller.
```

Example 5th.—Required the number of inches traversed by the back rollers per min.

3·1416
15·685 revols. of back rol. per min.
157080
251328
188496
157080
31416

back roller traverses 49·2759960 inches per min.

Example 6th.—Required the quantity of ½ Hank Slubbing, necessary to supply a "Jack Frame" 10 hours successively; having 72 spindles, 2 ends going up at each boss.

840 yds. = 1 hank
36 in. = 1 yd.
5040
2520
Divisor 30240

49·276
72
98552
344932
3547·872
2
7095·744
60 minutes
425744·640
10
30240)4257446·40(140·788 hanks required
30240
123344
120960
238464
211680
267840
241920
259200
241920

½ hank in 1 lb.
therefore
1 hank weighs 2 lbs.

140·788
2
281·576 lbs. wgt. required per 10 hours

EXAMPLE 7th.—From these particulars, find the revolutions of the spindles per minute.

frame shaft	286	revols. per min.	
wheel on frame shaft	80	teeth	driving
wheel on end of spindle shaft	42	,,	
wheel on same shaft	40	,,	
wheel on spindle	30	,,	

SOLUTION.

```
              42          286
              30           80
              —           ——
Divisor     1260        22880
                           40
          1260)915200(726·35 revols. of spindle per min.
               8820
               ————
                3320
                2520
                ————
                 8000
                 7560
                 ————
                  4400
                  3780
                  ————
                   6200
                   6300 nearly
```

EXAMPLE 8th.—Required the turns, or twists per inch in the "roving."

this divided 726·35 revols. of spindle
by that 374·36 inches traversed by front rol. per min.

```
            726·35
374·36(  ————————  (2 nearly
            748·72
```

EXAMPLE 9th.—Required the number of revolutions of spindles for one of front roller.

```
95·33)726·35(7.6193 revols. of spindle for one
      66731                of front roller
      —————
       59040
       57198
       —————
        18420
         9533
        —————
        88870
```

The Frame which is most admired at present in this neighbourhood, is that in which the winding on motion is regulated by means of the "sun wheel," the "internal wheel," and the "revolving stud wheel." But as the description would be of little service without drawings, the reader is under the necessity of making an inspection of the working parts, in order to understand the principles and processes of the calculations.

It will be evident on a little consideration, that the lapping up of the roving, is regulated by increasing or diminishing the speed of the bobbin, according as the bobbin follows the fly or the latter follows the former. The proportion, which the speed of the bobbin bears to its diameter, may be examined thus: suppose the front roller and empty bobbin are equal in diameter; then it is evident that the spindle must gain one revolution at the bobbin, for every revolution of the front roller, at this stage; and when the bobbin has increased to twice the diameter of the front roller, its speed must be increased so that the spindle shall only outrun the bobbin half a revolution for one of the roller. Therefore, as the bobbin's diameter increases 1, 2, or 3 times, its speed must increase on that of the spindle 1, ½, and ⅓ of a revolution respectively, for one of the front roller, when the bobbin follows the fly; but when the latter follows the bobbin, just the converse must take place.

The great difficulty formerly experienced of regulating this kind of frame by means of the "differential rack" and "friction plate" has been overcome by the introduction of the "internal wheel, and revolving stud wheel." The principle is such that by diminishing the revolutions of stud wheel, by means of a cone (having its extremes in proportion to the full and empty bobbin) the number of revolutions of the bobbin is increased so as to take up the roving no faster than it is delivered by the rollers.

Now the "sun wheel" is fast on the first propelled shaft, and gives motion to the "internal wheel" through the revolving stud wheel; the internal wheel is necessarily larger than the sun wheel, say double; in this case supposing the stud wheel to stand still, then the speed or revolutions of the internal wheel, will be half the speed of the sun wheel: which however must be made up by intermediate wheels, between that and the bobbins.

If we next suppose the stud wheel plate to revolve in the same direction as the sun wheel, the internal wheel will then be retarded; this being the principle upon which frames are now generally constructed, a *rule* will be given in another place, for ascertaining the speed of the "internal wheel."

The first question which arises in these calculations is this :—

How many revolutions per min. must the bobbins be retarded at the commencement, so as just to lap up the roving; the empty bobbin being 1¼ in.

Here the bobbin being the same diameter as the front roller, the proportion subsisting between the velocities of spindle and bobbin, when empty, will be expressed thus, 7·6193 to 6·6193 hence the following solution:—

As 7·6193 : 726·35 : : 6·6193
66193

217905
653715
72635
435810
435810

7·6193)4807928555(631·
457158

236348
228579

77695
76193

15025

Suppose the internal wheel to be 96, the centre or sun wheel 48; the next question which suggests itself is this:

How many revolutions must the internal wheel be retarded at the commencement of the bobbin, so as to just lap up the roving; or in other words, to give the bobbins the above number of revolutions.

The revolutions of internal wheel, and of sun wheel, will be proportional to those of spindles and bobbins; bearing in mind that the sun wheel has only half the number of teeth in the internal wheel, hence we have the following solution:—

As 726×96 : 286 : : 631×48
96 48

4356 5048
6534 2524

69696 30288
286

181728
242304
60576
69696)8662368(124·288
69696 [*Carried forward.*

CONTINUED.

169276
139392

298848
278784

20064·0
13939·2

612484
557568

549120

2)286

143

124·288

18·712 no. of revols. inter. wheel must be retarded.

Find the revolutions of bobbins from the following particulars.

wheel on the boss of inter. wheel	80	teeth	driving
a pinion of	42	,,	
on the same axis is a wheel of	80	,,	driving
* wheel on end of bobbin shaft	40	,,	
* on the same shaft, a wheel of	40	,,	driving
wheel on bobbin	30	,,	

42
30

Divisor 1260

124·28
80

994240
80

1260)745392·00(631· revols. of bobbins at the beginning
7560

3939
3780

1592
1260

3320

* *Omitted.*

From the following particulars find the revolutions of revolving Stud Wheel; at the commencement of the bobbin.

wheel on first propelled shaft	25	teeth	driving
wheel on grooved shaft	64	,,	
pulley on ditto	5	ins. diam.	driving
cone, lesser end of which is	2	,,	
bevil wheel on end of cone	18	teeth	driving
bevil whl. on short upright shft.	54	,,	
ditto ditto	20	,,	
stud wheel plate	150	,,	

[*Carried forward.*

CONTINUED.

```
          150                          25
           54                          18
           —                           —
          600                         200
          750                         25
          ————                        ————
         8100                          450
         64                             20
         ————                         ————
         324                          9000
        486                            286
        ————                          ————
        518400                       2574000
             2                             5
Divisor 1036800   10368|00)128700|00(12·4 revols. of stud wheel
                       10368               plate, at beginning
                       —————
                        25020
                        20736
                        —————
                         42840
                         41472
                         —————
                          1368
```

The following is a RULE *for finding the revolutions of the "internal wheel" when the revolutions of sun wheel and revolving stud plate are given.*

RULE.—Find how often the sun wheel is contained in the internal wheel; take the difference between the revolutions of sun wheel, and stud wheel plate; divide this by the quotient of sun and internal wheels.—Again, take the difference between this latter quotient and the revolutions of stud wheel plate; which result will be equal to the revolutions of the "internal wheel."

```
inter. wheel 96
             —=2            286
sun wheel    48              12·4
                            ————
                          2)273·6
                          ———————
                            136·8
                             12·4
                          ———————
                            124·4 revols. of internal wheel.
```

The above is applicable only when the stud wheel plate revolves in the same direction as the sun wheel; the following more general formula is applicable to any case, and will be better understood by those who are able to read algebraical language.

$$\frac{R}{R2}\left(S-C\right)+S=E$$

Where R represents the radius of sun wheel, R2 the radius of "internal wheel," S the revolutions of stud wheel plate, and C the revolutions of "sun wheel,"

$$\text{hence } \frac{48}{96}\left\{12{\cdot}4-286\right\}+12{\cdot}4=-124{\cdot}4$$

It must be observed that the "*negative*" result shows that the motion is contrary to that of the "sun wheel."

Find how many revolutions the bobbins must make when their diameters are double those of the empty bobbins.

Solution. The revolutions of the spindles to those of the bobbins, when empty, bear the proportion of 7·6193 to 6·6123, but when they have increased to twice their diameter, they must, in the same time, have increased their speed half a revolution for *one* of the front roller. Hence we must add ·5 or half a revolution, to the speed of the bobbins.

Thus 6·6193
·5
———
7·1193

Therefore speed of spin.
as 7·6193 : 726·35 : : 7·1193
7·1193
———
217905
653715
72635
72635
508445
———
7·6193)5171·103555(678·685 revols. of bobbins when diameters are doubled
457158
———
599523
533351
———
661725
609544
———
521815
457158
———
646575
609544
———
370310

The speed of the cone decreases as the bobbin's diameter increases; hence the revolutions of stud wheel plate when the bobbins have increased to double their original diameter will only be half their former number. viz :—6·2.

Find the revolutions of internal wheel, when the cone's speed is reduced to one-half, by the preceding *Rule.*

```
     286
       6·2
    ─────
  2)279·8
  ───────
    139·9
      6·2
    ─────
    133·7 revolutions of internal wheel
```

Find the revolutions of bobbins, with the above speed of internal wheel, from particulars given before.

```
  42           133·7
  30              80
  ──          ──────
1260         10696·0
                  80
            ────────
        1260)855680(679· revols. of bobbins
             7560         as shown above
             ────          very nearly.
              9968
              8820
              ────
              11480
              11340
              ─────
                140
```

The traversing of the bobbin rail is regulated by the cone, for as the bobbin increases in diameter the rail must move proportionally slower; because the same length is always given out from the rollers in the same time, and as circles are proportional to their diameters, it is evident that when the bobbin has increased to any given diameter, (say twice that of the empty bobbin,) that the traversing rail must move through only half the space in the same given time, for one lap at 2½ inches diameter will be equal to two at 1¼ inch; therefore the rail in the latter case must move at double the speed. Now, this just corresponds to the speeds of the cone at those respective stages. One or two examples may be given as illustrations in the calculations, connected with the traversing of the bobbin rail; but as the "thickness" of the rove is not easily ascertainable these are more matters of experience than of calculation.

Required the driving wheel on the end of cone shaft to make the bobbin rail traverse 1 inch for 18 revolutions of the front rollers; or, in other words, to make the bobbin rail traverse at the rate of 18 laps per inch when the bobbin is empty.

(Solution.) In the first place, find how many inches the bobbin rail must traverse per minute; or, which is the same thing, how many revolutions per minute the lifting shaft must make from the speed of front rollers and number of laps stated per inch.

By dividing the number of revolutions of the front rollers per minute by the number of laps per inch, thus

```
18)95·33(5·296
   90
   —
    53
    36
    —
    173
    162
    —
     113
     108
     —
       5
```

we get the number of inches traversed by the bobbin rail per minute, which being divided by the circumference of the wheel on lifting shaft, gives the revolutions per minute of that shaft,

```
    Thus          3·1416
                     2 in.  6·2832)5·29600(·8428  revols. of
                  ——————           502656         lifting shaft
Circumference of⎫ 6·2832           ——————         per minute.
 Wheel on lifting⎬ ——————            269440
 shaft.         ⎭                    251328
                                     ——————
                                      181120
                                      125664
                                      ——————
                                       554560
                                       502656
                                       ——————
                                        51904
```

From the following particulars, find the driving wheel on cone shaft.

Revolutions of cone per minute	264	(assumed)	
Bevil wheel driven by cone shaft	54	teeth	
Bevil wheel driving double reversing wheels	16	,,	
Reversing bevil wheels	96	,,	
Pinion on end of reversing shaft	20	,,	driving
Double carrier wheel and pin, 46 and	14	,,	working into
Wheel on end of lifting shaft	108	,,	
Revolutions of do. per minute	828		

264 revols. of cone
16
1584
264
4224
20
84480
14
337920
84480
Divisor 1182720

·8428
108
67424
84280
91·0224
46
5461344
3640896
4187·0304
96
251221824
376832736
401954·9184
54
16078196736
20097745920
1182720)21705565·5936(18 pinion required.
1182720
9878365
9461760
416605

The Rule for working the latter part of the above solution, may be found under the head, "Speeds," &c., *pages* 13 *&* 14.

Dyers' Frame.

Dyers' Patent Tube Frame is an American invention, and at its first appearance in this country obtained considerable popularity; its advantages consist in the greater quantity of work turned off by each hand; in space, turning, oil, and barrels; they have also a very neat appearance, which is a strong recommendation with some parties. But all these advantages are more than counterbalanced, I think, by the quality of yarn from these rovings, especially where a good wiry yarn is required. And notwithstanding the tube frame is less complicated than the fly frame, in its working parts, the former requires more skill and neatness in the attendants than the latter, to keep it in good working order; for without an amount of diligence and cleanliness which the fly frame does not absolutely require,—although very desirable, the tube frame soon spoils more work than amounts to the difference of cost in wages. This frame has two sets of rollers, or a double roller beam, three rows in each set; the cans are taken from the drawings, and the draught ranges from 20 to 30 and upwards. The following are the particulars for finding the draught.

Front roller pin	23	teeth.	driving
Shed wheel	46	,,	
Do. pinion	22	,,	driving
Second front roller wheel	46	,,	on the same axis.
A wheel of	27	,,	driving
Shed wheel	58		
and pinion	22		driving
Back roller wheel	58		
Diameter of front rollers	1⅛	in.	
Do. back ,,	1	in.	

From the above date find the draught of the tube frame.

Rule.—Multiply the driving pinions and diameter of back roller for a divisor; and also the driven wheels, and diameter of font roller for a dividend; the quotient is the draught.

Example.

Divisor 23 front rol. pin	Dividend 46 stud wheel
22 stud do.	46 driving wheel on 2nd front rol.
46	276
46	184
506	2116
27 driving pin on 2nd front rol.	58 stud wheel
3543	16928
1012	10580
13662	122728
22 stud pin (back)	58 back rol. wheel
27324	981824
27324	613640
300564	7118224
8 = 8ths—back rol.	9 = 1⅛
2404512	2404512)64064016(26·6
	4809024
	15973776
	14427072
	1546704

The bobbins on this frame are driven by surface turning; this is effected by means of a fluted boss to each roving; any small irregularity which may arise can easily be adjusted by two frustrums of cones, which are parts of the driving motion communicated to this shaft from the front roller.

If any one should be curious to know how to find any of the intermediate wheels in this particular case, he has only to refer to Example 1, page 14.

Mule Spinning.

The process of Spinning has always received a considerable share of the attention of Manufacturers, because of its great importance. And whether the task be assigned to the "Throstle" or the "Mule," it is universally acknowledged to be one upon which too much attention cannot be bestowed.

To make an even thread of any required counts, was long considered a great desideratum, with the manufacturers of Cotton Goods. The all but perfect accomplishment of this object by the successive inventions of Hargreaves, Arkwright, and Crompton, gave an impetus to the Cotton Manufacture unparalleled in the history of any other Art.

The invention of Hargreaves was said to have been suggested by the circumstance of seeing a common Spinning Wheel thrown over, which continued to turn for some time. The idea struck him that the wheel might be made having more than one spindle when standing erect. The machine which he made was the common Jenny; at first it consisted of eight spindles, but was afterwards enlarged to eighty.

But the most important invention in the art of Cotton Spinning was the application of rollers to draw out the thread; and although the merit of this invention has been awarded to Sir R. Arkwright, it appears to have been the subject of a patent *thirty* years before the date of Arkwright's patent. The name of the patentee was Lewis Paul; but the real author of the invention, was one John Wyatt of Birmingham. There was another individual who claimed priority of invention in the method of spinning by rollers; this was James Hays, or Highs, of Bolton; he is said to have been a very ingenious man; and he not only claims priority of invention, but asserts that the invention was stolen from him. In the trial of Arkwright's patent right, which took place in 1786, Highs brought witnesses forward to prove that the man whom he had employed to construct his machines had been inveigled away, and had communicated these plans to Arkwright, by whom he had been afterwards employed.

The first mill erected by Arkwright, was at Nottingham, and was turned by horses; but in the year 1771, he erected another at Cromford, which was turned by water.

In about ten years after the date of Arkwright's patent, another important improvement in Spinning Machines took place; this was the construction of the "Hand Mule," which, although a new machine, differed little in principle from the other machines then in operation; viz., the Common Jenny and the Water Frame. In the Common Jenny, the reduction of the roving into yarn was effected by allowing a certain quantity of rove to escape between a clasp, which opened and closed similar to a parallel rule; the carriage carried the roving and clasps and receded from the spindles. The Water Frame, as it was called on account of being turned by water, at Cromford, was the original of the common Throstle. In the Water Frame, the threads were drawn by means of rollers, instead of stretching; and it is the combination of these two modes of working in one machine, which constitutes the "Mule;" and for spinning fine numbers it has not been superseded by any other method. Samuel Crompton was the contriver of the Mule; but notwithstanding that it soon proved eminently adapted to the process of spinning, yet he never secured his improvement by patent, but allowed its adoption by others, toiling on in his own humble sphere, while others were taking advantage of the result of his skill and genius; however, he obtained a grant of £5000 from Government, in acknowledgment of his labour and ingenuity.

As soon as the powers of water and steam were applied to Mules, they began to increase in size as rapidly as they had increased in number; and not only did the Mules increase in number of spindles, but latterly, two or more have been connected together, and worked by one person with the same ease and facility as one pair was worked formerly. Nor did improvement stop even here, for the effect of strikes and combinations among the operatives, has been to cause employers to exert their own, and encourage the ingenuity of others, in order to diminish their dependence on the work hands. This has been accomplished, to some extent, by a variety of plans, but none can be said to have answered the purpose with such signal effect as the "Self-acting Mule."

The first Self-acting Mule was made by Mr. Strutt, of the family of that name, now of Belper and Derby; but it was never brought into practice. The most successful Self-acting Mules, are those of Messrs. Sharp and Roberts of Manchester, the first patent for which was taken out in 1825, and again, for improvement, in 1830.

Too much space would be taken up by a description of their working parts; and, moreover, as they are now so extensively adopted, it would almost be superfluous. I shall, therefore, give only the most important calculations.

Several other parties have taken out patents for Self-acting Mules, among which the next most successful to those of Sharp and Roberts', is that of Mr. Smith, of Glasgow.

Mr. Potter, of Manchester, has also patented a Self-acting Mule, of which a number have been made, and seem to give satisfaction.

Mr. Thomas Howard, of Hyde, has also brought out a Self-acting Mule, of very simple construction—a few have been made, and are now in operation, making excellent work, and giving promise of satisfaction, ultimately, in other respects.

DRAUGHTS, SPEEDS, AND OTHER CALCULATIONS.

Required the draught of the Mule from the following particulars.

Front roller pinion	29	teeth	driving
Crown, or Stud Wheel	90	,,	
Change pinion	24	,,	driving
Back wheel	42	,,	
Front roller	1	,,	in diameter
Back roller	$\frac{7}{8}$	,,	

Rule. Divide the product of driven wheels and diameter of front roller by the product of driving wheels and diameter of back roller. The quotient will be the roller draught.

```
  24             90
  20             42
  —              —
 480            180
   7           360
  —            ————
3360           3780
                  8
               ————
          3360)30240(9 roller draught.
               30240
```

Suppose the roller draught be 9, the roving 4 hank, stretch 60 inches, gaining 3 inches; what will be the counts of the yarn?

```
57 in.               9
                     4
                    —
                    36
                    60
                   ———
                57)2160(38's nearly.
                   171
                   ———
                    450
                    456
```

To find a wheel to put on the bottom end of long driver, to make the rollers deliver a certain number of inches in a given number of turns.

Rule. Multiply the number of turns and the driving wheels for a divisor, and multiply the number of inches to be delivered together with the driven wheels for a dividend; the quotient will be the wheel required.

Example. Suppose it were required to deliver 57 inches in 75 turns, with a 35 on the rim shaft, 33 on the top of long driver, 110 on the coupling shaft.

75 turns	57 inches
35	33
375	171
225	171
2625	1881
3·1416=Circumf. of fron rol.	110
15750	8246·70)206910·00(25. wheel required.
2625	1649340
10500	
2625	41976·00
7875	41233·50
8246·7000	74250

To find a scroll pinion that will draw out the carriage in a given number of turns.

Rule. Multiply the turns, the driving wheels, and the circumference of scroll for a divisor; and multiply the length of stretch and driven wheels for a dividend; the quotient will give the wheel required,

Example. Suppose a carriage is required to be brought out 60 inches in 75 turns, with a 20 pinion on rim shaft, 120 on short driver shaft, 160 scroll wheel, diameter of scroll 10 inches.

3·1416	60 inches
10	120
31·416 Circumf. of Scroll.	7200
75	160
157080	432000

[*Carried forward.*

219912
2356·200
20
47124·000

72
47124)1152000(24. pinion required.
94248
209520
188496
21024

Rule. To find the twist or turns of the spindle per inch of yarn for both Twist and Weft.

Rule. For "twist" multiply the square root of the counts by 3·75 or 3¾; and for "weft" multiply the square root of the counts by 3·25, or 3¼; the respective products will be the turns per inch required.

Required the twists per inch for 36's twist yarn.

36
6 square root.
3¾
18
4½
22½ twist.

3·75
6 square root.
22·50

ANOTHER.

Multiply the counts of yarn by 12, the square root of which will give the turns per inch for twist. Weft will require from 3 to 3½ turns per inch less from Nos. 30's to 40's.

Example. 36
12
432(20 turns.
2×2=4)4
32

again 60
12
720(27 nearly.
2×2=10)4
320
329

This rule gives a result about 1-10th less than the preceding.

To find the No. of revols. of spindles for one of rim.

Rule. Multiply the diameters of driving pulleys together for a dividend, and the driven pulleys for a divisor, the quotient will be the revols. of spindles for one of rim.

If the rim be 32 inches diameter, rim band pulley 26, and twist pulley 15 inches, wharves ¾ inch; what number of revols. will spindles make for rim one?

EXAMPLE. 32 26
15 ·75=¾ in.
160 130
32 182
Dividend. 480 Divisor 19·50)480·0(24·6 revols. of spindles for 1 of rim.
390
900
780
1200
1170
30

EXAMPLE 2. If the rim be 22 inches, rim band pulley 20 inches, twist pulley 13, and wharves 7-8ths of an inch; how many revols. will spindles make for rim one?

·875=7·8 in. 22
20 13
17·500 66
22
17·5)286(16·34 revol. of spindle for 1 of rim.
175
1110
1050
600
525
750
700
50

From the following data find the "twist," or "Bell Wheel."

Length of Stretch 60 inches.
Number of twists per inch, 22.5.
Revolutions of spindles for 1 of rim, 15.

Rule. Multiply the twists per inch by the length of stretch; and divide this product by the number of revols. spindles make for 1 of rim.

Example.

```
    22·5
      60
15)1350·0(90 twist wheel.
   1350·0
```

Self-Acting Mules.

SHARP AND ROBERTS.'

The following calculations are taken from both Twist and Weft Mules, spinning from 34's to 40's.

Required the speed of the twist shaft from the following particulars:

Revolutions of principal shaft	140	per min.
Diameter of drum on do.	21	inches
Diameter of pulley on counter shaft	14	,,
Diameter of drum on do. do.	16	,,
Diameter of pulleys on twist shaft	12	,,

```
 14            140
 12             21
 —             ———
168            140
              280
              ———
             2940
               16
             ————
            17640
            2940
            —————
       168)47040(280 revols. of twist shaft.
            336
            ————
            1344
            1344
```

Required the speed of the front rollers from the following particulars:

Revolutions of twist shaft per min.	280	
Back pinion on twist shaft	18	
Back change wheel, on back shaft	54	teeth
Wheel on the other end of back shaft	40	driving
Wheel in connexion with catch box	40	

Divisor, 54

280 revols.
18

2240
280

54)5040(93·33
486

180
162

180
162

180
162

* omitted.

18

From the following particulars find the roller draught.

Wheel on front rollers	18	teeth
Crown wheel	112	„
Change pinion	42	
Back roller wheel	48	
Diameter of front roller	1	inch
back roller	$\frac{7}{8}$	„

42	112
18	48
336	896
42	448
756	5376
7	8-eights of inch.
5292	5292)43008(8.127 nearly

42336

6720
5292

14280
10584

36960
37044

Required the speed of the long drawing out shaft from the following particulars:

Revolutions of twist shaft per min.	280		
Back pinion of twist shaft	18	teeth	driver
Back change wheel on back shaft	54	,,	driven
Pinion on back shaft	19	,,	driver
Wheel on long drawing out shaft	61	,.	driven

54
61
54
324
3294

280
18
2240
280
5040
19
3294)95760(29·071 revol of long drawing out shaft.
6588
29880
29646
23400
23058
3420
3294
126

Find the speed of drawing out scroll from the following data:

Revolution of long drawing out shaft per min.	29·071.	
Bevil wheel on do.	25	teeth
Bevil wheel on scroll shaft	48	

Divisor 48

29·071
25
145355
58142
48)726·775(15·141 revols. of drawing out scroll.
48
246
240
67
48

[*Carried forward.*

```
 197
 192
 ───
  55
  48
  ──
   7
```

Find the speed of drawing out scroll from these particulars.

Revolutions of twist shaft per min.	280		
Back pinion on twist shaft	18	teeth	driver
Back change wheel on back shaft	54	,,	driven
Pinion on back shaft	19	,,	driver
Back change wheel on long drawing out shaft	61	,,	driven
Bevil wheel on do. do.	25	,,	driver
Bevil wheel on drawing out scroll	48	,,	driven

```
     54                    280
     61                     18
     ──                    ───
     54                   2240
    324                   280
    ────                  ────
   3294                   5040
     48                     19
   ─────                 ─────
  26352                  45360
 13176                   5040
 ──────                  ─────
 158112                  95760
                            25
                        ──────
                        478800
                       191520
                       ───────
               158112)2394000(15·141
                       158112
                       ──────
                        812880
                        790560
                        ──────
                         223200
                         158112
                         ──────
                          650880
                          632448
                          ──────
                           184320
                           158112
```

Suppose the drawing out scroll be 6¾ inches diameter, making 15·141 revolutions per minute; how many inches will the carriage traverse per minute?

3·1416 Circumference when diam.=1
6·75=6¾

157080
219912
188496

21·205800=circumference of scroll.
15·141

21205800
84823200
21205800
106029000
21205800

321·077017800 inches drawing out scroll traverses, or carriage travers. per minute.

Find the number of inches traversed by front rollers per minute.

93·333 revolutions of front roller per minute.
3·1416

559998
93333
373332
93333
279999

293·2149528 inches traversed by front rollers per minute.

Required the length delivered by the front rollers per stretch from this data.

Carriage traverses	321·077	inches per minute.
Front rollers traverse	293·215	,, ,,
Length of stretch	61	inches.

The length delivered from the rollers is in the same proportion to the length of stretch, as the number of inches traversed by the rollers per minute, is to the inches traversed by carriage.

293·215
61

293·215
1759290

321·077)17886·115(55·7

1605385

1832265
1605385

2268800
2247539

21261

The speed of the quadrant shaft is required from these data.

Revolutions of drawing out scroll per minute, 15·141
Diameter of do., 6·75 inches.
Diameter of drum on quadrant shaft, 6·125 inches.

15·141
6·75

75705
105987
90846

6·125)10220175(16·686 revolutions of quadrant shaft per minute.
6125

40951
36750

42017
36750

52675
44900

37750
36750

1000

Required the number of teeth the quadrant moves per stretch from these particulars.

Carriage traverses 321·077 inches per minute:
Revolutions of quadrant shaft per min., 16·686.
Wheel on quadrant shaft, 22 teeth.
Length of stretch 61 inches.

```
            16·686
                22
            ------
             33372
            33372
            ------
           367·092
                61
            ------
            367092
          2202552
          --------
321·077)22392·612(69·7 number of teeth quad-
          1926462      rant moves per stretch.
          -------
           3127992
           2889693
           --------
            2382990
```

Required the twists per inch, from the following particulars:

"Twist," or "Bell Wheel" worked by a worm on twist shaft, 70 teeth
Diameter of Pulley on twist shaft 18⅝, or 18·625 inches.
Diameter of wharves on spindles ⅞, or ·875 inches.
Length of stretch 61 inches.

```
   ·875                  18·625
     61                      70
   ----                  ------
    875         53·375)1303750(24·4
   5250                106750
   ------              ------
 53·375                 236250
                        213500
                        ------
                         227500
                         213500
                         ------
                          14000
```

N.B.—61 *Inches are seldom put up except in spinning low numbers. These calculations are intended to have as wide a range as possible without a multiplicity of examples.*

Find the speed of the short going-in shaft from these data.

Revolutions of twist shaft per minute,	280.
Wheel on loose pulley,	30 teeth.
Wheel on short going-in shaft,	44

```
    280
     30
   ----
44)8400(190·9
   44
   ----
   400
   396
```

The speed of long going-in shaft is required from these data.

Revolutions of twist shaft,	280	per minute.
Wheel on loose pulley	30	teeth.
Wheel on short going-in shaft	44	,,
Do. do.	15	,,
Wheel on long going-in shaft	22	,,

```
  44              280
  22               30
  --             ----
  88             8400
 88                15
 --             -----
968             42000
                8400
               ------
           968)126000(130·165
               968
               ----
                2920
                2904
                ----
                 1600
                  968
                 ----
                 6320
                 5808
                 ----
                  5120
                  4840
                  ----
                   280
```

The speed of the going-in scroll shaft is required from the following data:

Revolutions of twist shaft per min.	280	
Wheel on loose pulley	30	teeth.
Wheel on short going-in shaft	44	„
Do. do.	15	„
Wheel on long going-in shaft	22	„
Bevil Wheel on do.	16	„
Bevil Wheel on scroll shaft	44	„

44	280
22	30
88	8400
·88	15
968	42000
44	8400
3872	126000
3872	16
Divisor, 42592	756000
	126000

42592)2016000(47·33 revols. of going-in scroll per min.
170368

312320
298144

141760
127776

139840
127776

12064

The speed of the backing-off wheel is required from these data.

Revolutions of long going-in shaft,	130·165	per min.
Wheel on do.	12	teeth.
Backing-off wheel	77	„

Divisor, 77 130·165
12

77)1561·980(20·285 revolutions of backing-off wheel.
154

[*Carried forward.*

CONTINUED.

219
154

658
616

420
385

Find how many revolutions the spindles must make at the commencement of the set, so as just to wind on the stretch; from these data.

Length of stretch, 61 inches,
Diameter of spindles $\frac{1}{4}$ inch,

3·1416
·25

157080
62832

Circumfer. ·785400 of spindle.

·7854)61·0000(77·667 revols of spindles.
54978

60220
54978

52420
47124

52960
47124

58360
54978

3382

Required the revolutions of winding on drum per stretch, at the commencement of the set, from these data.

Revolutions of spindles per stretch, going-in	77·667
Diameter of wharves,	·875 inch.
Wheel on winding on drum,	44 teeth.
Pinion on do. shaft,	25 ,,
Diameter of vertical shaft pulley	10·55 inches.

10·25
44

4100
4100

77·667
25

388335
155334

[*Carried forward.*

CONTINUED.

```
451·00          1941·675
                    ·875
                ————————
                 9708375
               13591725
              15533400
              ————————
        451)1698·965625(3·767  revols. of winding
            1353                 on drum per stretch.
            ————
             3459
             3157
             ————
              3026
              2706
```

If the winding on drum make 3·767 revolutions per stretch of 61 inches; what is its circumference?

```
     3·767)61000(16·19  circumference of winding
            3767              on drum.
           ————
            23330
            22602
            —————
              7280
              3767
              ————
              35130
              33903
              —————
               1227
```

If the circumference of winding on drum be 16·19 inches, what will be its diameter?

```
     3·1416)16·1930(5·15 diameter of winding on
              157080        drum.
              ——————
               48500
               31416
               ——————
               170840
               157080
               ——————
                13760
```

N.B.—This of course includes the thickness of chain, which must be deducted, to give the diameter of drum.

Smith's Self-Acting Mules.

The following are some of the particulars of these mules; forming data for the annexed calculations.

" Principal driving shaft,	190 revolutions per minute.	
" Pulley on do.	10½ inches diameter	driving
" Second driving shaft on which is a wheel	24 teeth	driving
" A wheel on end of suspension shaft	84 ,,	on the other end
" A pinion of ,,	12 ,,	driving
" Mangle wheel containing	151 ,,	
" Reversing part ,,	39 ,,	
" Rack wheel ,,	138 ,,	driving
" Double carrier on top shaft	56&67 ,,	driving
" Wheel on end of friction pulley shaft	55 ,,	on the same shaft

A plate carrying two pinions which gear into the central wheel and internal wheel, which latter is fast to the grooved friction pulley.

" Central wheel	60 teeth.	
" Internal wheel	100 ,,	
" Wheel (in connexion with central wheel)	88 ,,	driving
" Winding on wheel	104 ,,	

Example 1. Required the speed of *pinion* driving mangle wheel from the above data.

14	190 revolutions of principal shaft
84	10·5
56	950
112	1900
1176	1995·0
	24 = first driving wheel.
	7980
	3990

[*Carried forward.*

CONTINUED.

1176)47880(40·714 For the rule to find
4704 speed see pages 13 & 14.
8400
8232

NOTE.—This pinion draws the carriage out, and returns it by acting alternately on the inner circumference, and on the reversing part of the mangle wheel.

EXAMPLE 2. Required the speed of the mangle wheel, while drawing out.

from 151 = whole No. of teeth
substract 39 = reversing part
112 = Divisor.

40·714 revols of pinion
12
112)488·568(4·3622 revols of
448 mangle wheel
405
336
696
672
248
224
240
224
16

If no time were occupied in putting up the carriage, the mule would make 4·3622 stretches per minute.

EXAMPLE 3. Required the average, or medium speed of mangle wheel while going in.

40·714 speed of pinion.
12
reversing part 39)488·568(12·527 revols. of mangle
39 going in.
98
78

[*Carried forward.*

CONTINUED.

205
195
106
78
288
273
15

EXAMPLE 4. From the above two speeds of mangle wheel, find the time required to complete a stretch.

Seconds.	Seconds.
4·3622)60·0000(13·75 Seconds.	12·527)60·000(4·789
43622	50108
163780	98920
130866	87689
329140	112310
305354	100216
237860	120940
218110	112743
19750	8197

Seconds.
13·75 = time required for drawing out.
4·789 = do. going in.

18·539 = time required to complete one stretch.

EXAMPLE 6. Required the speed of grooved friction pulley shaft, which carries the pinions, driving, central and internal wheels.

Revolutions of mangle wheel,	12·527 per minute going in.	
Rack Wheel	138 teeth	driving
Double Carrier	56 & 67 ,,	driving
Wheel on friction pulley shaft	55 ,,	

56	12·527
55	138
280	100216
280	37581

[*Carried forward.*

CONTINUED.

```
    ————           12527
    3080          ———————
                  1728·726
                        67
                  ————————
                  12101082
                 10372356
                 ————————
             3080)115824·642(37·605 revols. of fric-
                  9240               tion pulley shaft
                  ——————             per minute.
                   23424
                   21560
                   ——————
                    18646
                    18480
```

NOTE.—This shaft carries round the pinions which geer into the central and internal wheels; the former being driven quicker, or slower, according as the latter is held fast or otherwise, by the friction band in the groove.

EXAMPLE 7. To find the speed of central wheel, supposing the internal wheel to be held fast by the friction band.

RULE. Multiply the sum of the two wheels (central and internal) by the revolutions of the shaft, carrying the pinion, and divide the product by the central wheel; the quotient is the speed of central wheel.

```
Thus 100          37·605 revols. of shaft carrying pinions
      60             160
     ————         ———————
     160          2256300
                  37605
                  ——————————
               60)6016·800
               ————————————
                  100·28 revols. of central wheel per min.
```

EXAMPLE 8. Find how many revolutions the spindles must make to wind on a stretch 62 inches diameter of spindles being 1-5th inch, or 2.

```
          3·1416        ·62832)62·0000(98·6758 revols. of spin-
              ·2               565488               dles.
          ——————               ——————
Circumf. ·62832 of spindle.     545120        [Carried forward.
```

CONTINUED.

502656

424640
376992

476480
439824

366560
314160

524000
502656

21344

EXAMPLE 9. Find how many revolutions the winding on wheel (lower catch wheel) must make to give the spindles the above number of revolutions; from the following data.

Grooved twist pulley	13·5	inches diam.	driving
Pulley on end of roller	6·5	,,	,,
Roller driving spindles	5	,,	,,
Wharves	¾ or ·75	,,	,,

13·5 98·6758 revols. of spindles to wind on 62 in.
5 6·5

67·5 4933790
5920548

641·39270
·75

320696350
448974890

67·5)481·044525(7·12658 revols. of winding on wheel.
4725

854
675

1794
1350

4445
4050

[*Carried forward.*

Continued.

3952
3375

577

Example 10. Find how many revolutions the central wheel must make to give the winding on pulley the revolutions found in last question, from these data.

Wheel fast to central wheel	88	teeth	driving
Winding on wheel	104	,,	

Divisor 88

7·12658 revols. of winding on wheel.
104

2850632
7126580

88)741·16432(8·4 revols. of central wheel to wind 62 inches with bare spindle.
704

371
352

By inspection of the last question, and questions 7 and 13, it will be evident that the grooved friction pulley does not require holding fast; but must revolve less or more according as the cop enlarges. However, it must be remembered that the last two questions have been solved without taking into consideration that the spindles are moved by the going in of the carriage; the roller is made to revolve the number of times indicated, by dividing the length of stretch, by the circumference of pulley on the roller end. Therefore let the next question be

Example 11. To find how many revolutions the spindles acquire by the motion of the carriage going in.

3·1416
6·5

157080
188496

Circ. of 20·42040 pul. on roller

inches.
20·42)62·00(3·03623 revols. of roller by the going in of carriage.
6126

7400
6126

12740·
12252

[Carried forward.

CONTINUED.

4880
4084
7960

3·03623 revols. of roller by motion of carriage.
5 = diam. do.

Diam. of wharves ·75)15·18115(20·24 revols. of spindles by motion of carriage.
150
181
150
311
300
11

Therefore the actual number of revolutions of the spindles worked by the winding-on motion will be 78·4358.

EXAMPLE 12. How many revolutions must the central wheel make to move the spindles what is required.

External wheel attached to central wheel,	88	teeth	driving
Winding on wheel	104	,,	
Twist pulley on same shaft	13·5	inches diam.	driving
Pulley on end of roller	6·5	,, ,,	
Roller	5·	,, ,,	driving
Spindle wharves	·75	,, ,,	
Number of revols. required	78·4358		

*88
13·5
440
264
88
1188·0
5
5940

78·4358*
·75
3921790
5490506
58·826850
6·5
29413425
35296110
382·374525
104

---

* *See Rule, page* 13, *for finding speeds, &c.*

[*Carried forward.*

Continued.

```
      1529498100
     3823745250
     ──────────
5940)39766·950600(6·6947 actual revols. of cen-
     35640                tral wheel per stretch
     ─────                going in.
      41269
      35640
      ─────
       56295
       53460
       ─────
        28350
        23760
        ─────
         45906
         41580
         ─────
          4326
```

Example 13. Required the actual revolutions of central wheel per min. when spindles are bare.

```
      Seconds.         Revolutions.         Seconds.
As     4·789     :       6·6047       : :      60
                             60
                         ──────
              4·789)401·6820(84· revols. of central
                    38312          wheel per min.
                    ─────
                     18562
                     19156
                     ─────
                       406
```

Required to find how many revolutions the internal wheel will make, allowing 84 for the central wheel, and 37·6 for the revolving pinions.

For Rule, see Example under the head "Roving Frame," which is precisely applicable in this case.

The number of times central wheel is contained in the internal is 5-3rds.

$\frac{37·6—84}{5\text{-3rds.}} \times 37·6$ = The revolutions of internal wheel.

—84
37·6

—46·4
3

5)139·2

—27·84

37·6
—27·84

9·76 revols. of internal wheel.

If the revolutions of central wheel were less than those of the pinions, the solutions would be more simple, having no negative quantities. The only difference between this and the example under the head "Roving Frame" is, that in the present case the "answer" is a positive number, showing that the motion of the internal wheel is in the same direction as the central wheel. See page 44.

I think it must be acknowledged that the plan of regulating the winding motion by the friction band and pulley in these mules, is far from being so consistent with the mechanical and mathematical skill of the day, as the quadrant and winding-on drum of Roberts' Mule; the latter can be regulated with almost mathematical precision, by the radius worm of the quadrant, while the working of the former depends in a great measure upon cleanliness; the smallest quantity of dirt often doing much mischief.

Example 14. Find how many revolutions the spindles make for one of the rim, or first driving shaft from the following data.

Rim on first driving shaft	28¾	inches	diam.	driving
Pulley on twist shaft	12½	,,	,,	
Grooved twist pulley	13½	,,	,,	driving
Do. pulley on roller	6½	,,	,,	
Roller	5	,,	,,	driving
Wharves	¾	,,	,,	

diam. of 12·5 back pulley
6·5

625
750

81·25
75

40625
56875

Divisor 60·9375

28·75 diam. of rim.
13·5

14375
8625
2875

388·125
5

60·9375)1940·625(31·8 revols. of spindle for one of rim.
1828125

[*Carried forward.*

Continued.

1125000
609375

5156250
4875000

281250

Example 15. The revolutions of spindles per minute, are required from the following data.

First driving, or rim shaft, 190 revols. per minute.
Revolutions of spindle, 31·8 for rim one.

190
31·8

1520
190
570

6042·0 revol. of spindle per minute.

Example 16. Required the revolutions per minute, and also the number of inches traversed by front roller per minute from these data.

Mangle, or Rack wheel makes	4·3622 revols. per min.	driving
Double Carrier on top shaft	56 & 82 teeth	driving
Double Carrier on Stud	20 & 39 ,,	driving
Wheel on front roller	18 ,,	
Front roller	1 inch diam.	
Rack Wheel contains	138 teeth.	

56
20

1120
18

8960
1120

20160

4·3622 revols. of rack wheel per min.
138

348976
130866
43622

601·9836
82

12039672
48158688

49362·6552
39

[*Carried forward*

Continued.

4442638968
1480879656

20160)1925143·5528(95·4932 revols. traversed
181440 by front rollers per min.

110743
100800

99435
80640

187955
181440

65152
60480

46728
40320

6408

95·4932
3·1416

5729592
954932
3819728
954932
2864796

Front roller traverses 300·00143712 inches per minute.

Required the turns, or twists per inch of the yarn, from these data.

6042 revols. of spindles per minute.
300· inches traversed by front rollers.
300)6042(20·14 twists per inch.
600

420
300

Suppose it were required to give the yarn 22 twists per inch instead of 20·14, what must be the diam. of the back twist pulley?

	twists.		twists.		inches.
As	20·14	:	12·5	: :	22

22
250
250
20·14)275·00(13·7 diam of pulley.
2014
7460
6042
14180
14098
82

Suppose it were required to alter the gaining of the carriage from 2 inches to 4, (the length of stretch being 60 inches) by changing the driven wheel in connexion with the rack wheel; what number of wheel will be required, the present one being 56?

Length delivered from rollers.

	inches.		inches.		teeth.		teeth.
As	56	:	58	: :	56	:	58 wheel required.

In this case the carriage traverses at the same speed, but the speed of the rollers is diminished; this being the only alternative except changing the Rack, or Mangle Wheel.

Since the former editions of this work were published, the *winding-on motion*, described in the preceding Examples, has been very generally superseded by the "cone winding motion;" which seems to answer very well, and is also a very ingenious contrivance; but one, of which the calculations could only be followed by those who have made themselves acquainted with the proportion of curves.

The Throstle Frame.

The Throstle Frame was invented by Sir Richard Arkwright; and is now, for spinning the lower and medium numbers of yarn for warp, in very general use; indeed the superiority of the yarn known as "*Water Twist*" is sufficiently indicated by the general repute in which it is held. Improvement has by no means been idle; for the throstle frame of the present day is a great change on the original; although the main principles remain the same. The constant stretching of the thread by the drag of the bobbin renders the yarn entirely free from "snarls" with which every one is familiar in Mule Yarn. The thread is also more wiry and smooth; its elasticity is greater when properly managed; but there is a limit beyond which the throstle cannot compete with the mule.

"Throstle," like Mule Spinning, requires a degree of tact in its management, which is only acquired by long and patient experience.

The following particulars will serve to show the calculations of this frame.

Wheel on tin roller	42 teeth	driving
Carrier wheel	135 ,,	
Change do.	48 ,,	driving
Wheel on front roller	82 ,,	
Diameter of tin roller	9 inches	
Do. do. wharve	⅞ inch	
Do. do. front roller	1 ,,	

From the above particulars find the revolutions of spindle for 1 of front roller.

42	135
48	82
336	270
168	1080
2016	11070
·875 = ⅞ inches	9
10080	1764.)99630(56· revol. of spindle for 1 of rol.
14112	8820
16128	
1764·000	

[*Carried forward.*

CONTINUED.

11430
10584

846

Find the number of turns per inch, from the foregoing data.

EXAMPLE 2nd. 3·1416)56·4700(18 turns nearly.
31416

250540
251328

Find a change wheel to produce 16 turns per inch with the following data:

tin roller wheel	40
Wheel on front rol.	80

All the rest as above.

RULE. Multiply the diameters of wharve by the circumference of front roller and by the wheel on tin roller, and turns per inch required for a Divisor; and likewise the driven wheels and diameter of tin roller for a dividend, the quotient give the wheel required.

Ex. 3rd. 3.1416 circ. of front rol.
·875 diam. of wharve

157080
219912
251328

2·7489000
40 tin rol. whl.

109·9560000
16 turns required.

6597360000
1099560000

1759·2960000

135
80

10800
9

1759·296)97200·000(55· whl. required.
8796480

9235200
8796480

438720

Circum. of front roller.
8)3·1416

·3927
7

2·7489 = $\frac{7}{8}$
8

21.9812

135
9

21·9812)12150000(55
1099060

1159400
1099060

60340

Loss in Working.

To find the loss in working, divide the product of the draughts by the product of the doublings, which of course gives the real length of any given weight, spread on one yard at the Lap Machine.

Then find the counts by dividing the length formed by the given weight multiplied into one hank.

FOR EXAMPLE,

Suppose there is 20 oz. of cotton spread on one yard at the Lap Machine; the counts of yarn produced being 40's. What is the loss in working with the following draughts and doublings? viz:—

DOUBLINGS.	
Sliver Lap Machine	68
Total at drawing frame	216
Slubbing frame	2
Roving frame	2

DRAUGHTS.	
Lap Machine	2
Breaker Card	68
Finisher Card	140
Drawing frames	287·5
Slubbing do.	6
Roving do.	7
Mule	9

```
  216
   68
 ----
 1728
1296
 ----
14688
    4
-----
58752
```

```
     68
      2
      -
    136
    140
   ----
   5440
  136
  -----
  19040
  287·5
  -----
  95200
 133280
152320
38080
-------
5474000·0
        6
  -----
```

[*Carried forward.*

CONTINUED.

```
                 32844000
                        7
                 ---------
                229908000
                        9
                ---------
      58752)2069172000(35218·7 length in yds. at
                176256                the mule.

Then   1.25 = 20 oz.          1050)35218·7(33·54 counts of yarn
       840 = 1 hank                3150          without loss.
       ----                        ----
        5000                        3718
      1000                          3150
      ----                          ----
      1050·00 Divisor.               5687
                                     5250
                                     ----
                                      4370
                                      4200
                                      ----
                                      170
```

The yarn actually produced is 40's. And further, the counts shown by the draughts, and the counts produced are proportional to the weight of cotton and yarn in the inverse ratio.

```
                                   oz.
Thus :   As 33·54's     :          20        : :       40's.

                   34·54
                     20
                   -----    oz.
              40)670·80(16·77 or, 16 ozs. 15 dwts. 9 grs.
                 40
                 --
                 270
                 240
                 ---
                  308
                  280
                  ---
                   280
                   280

             oz.     dwts.    grs.
             20        0        0
             16       15        9
             ---------------------
              3        4       15  loss in working.
```

If the given weight be spread on 30 inches, which is very generally the case, reduce it to the weight spread on 36 in the following manner, which will greatly facilitate the process of finding the loss.

Thus: As 30 in. is to the weight on 30 inches; so is 36 in. to the weight on 36.

Suppose 16 oz. be spread on 30 inches; what weight will be on 36 inches?

```
      in.            oz.            in.
As    30      :      16     : :     36
                     36
                     ——
                     96
                    48
                   ———
                 3|0)57|6
                 ————
                   19.2 or 19 one-sixth.
```

The loss in working may also be found at the end of any operation in the following manner:

Divide the product of the given weight (in grains) and number of doublings by the draughts, upon any operation you wish to try; the result will be the weight of the original length in grains, without loss; from which subtract the real weight of the same length, which will give the loss.

If 20 ozs. of cotton are spread on 36 inches at the Lap Machine, and with the preceding draught and doublings, rovings of 4 hanks in the pound be produced, what is the loss in working at the end of any operation?

```
          140=Finishing Card           437·5=1 oz.
            2                             20
          ———                          ———
          280                          8750·0
        287·5=Drawing Frames.          216  Drawing Frames.
          ———                         ———
         1400                        52500
        1960                         8750
       2240                         17500
       560                         ————
       ———                         1890000
       805000                            2
             6 Slubbing Frame.     ————
       ————                        3780000
      4830000                            2
             7 Roving Frame.       —————      grs.
    ————              3381300·0)7560000(2·236 weight of 1 yd.
Divisor 3381000·0               6762000         of hank roving
                                ————             without loss.
```

[*Carried forward.*

CONTINUED.

7980000
6762000

12180000
10143000

20370000
20286000

2·236 weight of 1 yard of 4 hank roving.
2·083 nett weight of

·153 loss at 1 yard.
840

6120
1224

128·520 loss at 1 hank.
4

514·08 or

1 oz. 3 dwts. 4·58 grs. loss at 1 ℔.

The Table given at page 110 will be useful for finding readily the nett weight of any given length of lap, drawing, or end, if the counts be known.

Thus: One yard is the 840th part of an hank.

Therefore 7000 grains divided by 840, gives 8·333, which being divided by the known counts (the hank, or proportion of a hank,) will give the nett weight of one yard.

Dividend.
Hank 4)8·333

2·0833 grs. nett weight of 1 yard of 4 hank roving.

Dressing Frame.

The calculations which apply to the Dressing Frame (with very slight variation) are common to all kinds of frames, especially those calculations that pertain to the regulation of the length of the cut.

It is generally the practice to allow one or two yards more at the dressing frame than the required length of the cut: part of this is taken up in weaving, and the remainder forms a fent.

The diameter of sizing roller, and the length of the cut being given to find the Bell wheel.

Rule.—Divide the length of the piece, or cut in inches, by the circumference of the roller; the quotient is the revolutions of roller, or the number of teeth in a Bell wheel. For a single worm.

Suppose it were required to make the pieces 31 yards in the Dressing Frame; what must be the Bell wheel, the diameter of the sizing roller being 10 1·8th inches?

```
1-8th.    3·1416                  31 yards.
            10⅛                   36
         -------                  --
         314160                  186
           3927                  93
         -------                 ----
        31·8087        31·8087)1116·0000(35, or 70 for dou-
                                954261          ble worm.
                                -------
                                1617390
                                1590435
                                -------
                                  26955
```

With the same dimensions of roller, what wheel will be required to make the pieces 27 yards?

```
                in.  in. 27 yards.
        31·8087)972·0000(30·5  or 61 with double worm.
                954261
                ------
```

[*Carried forward.*

Continued.

1773900
1590435

183465

Or thus: yds. wheel, yds.
As 31 : 70 : : 27
27

31)1890(61 nearly.
186

Here we see the advantage of a double worm; by that means the length can be regulated to half a revolution of the size roller.

From the following particulars of the self-marking apparatus of a Sizing Frame, find the driving wheels on the "neck" roller; marking each half cut.

Diameter of "neck" roller,		4 inches	
Wheel on	do.	(required)	driving
Wheel on Stud		41 teeth	on the same axis is a worm driving
A Wheel of		44 „	
Required length of piece		26¼ yards.	

26·25 yds.
36

15750
7875

½)945·00 = inches 1 cut.

472·5 = ½ cut

3·1416
4

12·5664 circumf. of roller.
41

125664
502656

515·2224
44

20608896
20608896

472·5)22669·7856(48 wheel required.
18900

37697
37800 nearly.

The last example shows how to find a *driving* wheel; from the same data, find one of the *driven* wheels; the second for instance.

```
                3·1416                    472·5 inches in half a cut
                     4                       48 driving wheel.
                ------                     -----
Circumf. 12·5664 of neck rol.             37800
              41                         18900
          ------                         -----
          125664             515·2224)22680·00(44
         502656                         2060888
         -------                        -------
       [515·2224                         2071120
                                         2060888
                                         -------
                                           10232
```

From the same data find the exact circumference of "neck" roller.

```
     41                  472·5 inches in a half cut.
     44                     48
     --                  -----
    164                   37800
   164                   18900
   ----                  -----
   1804             1804)22680·0(12·572 circumference of
                         1804                "neck" roller.
                         ----
                          4640
                          3608
                          ----
                          10320
                           9020
                          -----
                           13000
                           12628
                           -----
                              3720
                              3608
                              ----
                               112
```

Power Looms, &c.

The number of picks per minute is required from the following particulars :

Revolutions of driving shaft per min.	96
Diameter of drum on do.	16 inches.
Diameter of pulley on loom	10·5 „

```
Divisor, 10.5              96
                           16
                           ——
                          576
                          96
                          ———
           Divisor 10·5)1536(146 revolutions of crank shaft
                        105           or picks per min.
                        ———
                         486
                         420
                         ———
                          660
                          630
                          ———
                           30
```

If the crank shaft of a loom make 146 revolutions per minute; how long will it be in weaving a piece 29 yards long, 72 picks to the inch?

```
Divisor, 146               29
                           37
                           ——
                          203
                          87
                          ————
                         1073
                           72
                          ————
                         2146
                        7511
                        —————
```

[*Carried forward.*

CONTINUED.

146)77256(529·15 minutes, or 8 hours 49 min.
730
425
292

Required the weight of twist and weft to make a piece of the following description:

Length of piece, 29 yards
Count of Reed, 64· (Manchester and Stockport)
Count of Yarn; twist 34's, Weft 36's
Width of Warp at Reed, 20 inches.
No. of picks per inch, 72.

For the twist 29 yds. length of piece,
64 counts of reed.
116
174
1856
29 width in reed.
16704
3712
1 Hank = 840 yds.)53824(64·076 hanks of twist required for the piece.
5040
3424
3360
6400
5880
5200
5040
160

For the weft 29 yds. length of piece
72

[*Carried forward.*

CONTINUED.

```
                                  58
                                 203
                                ----
                                2088
                                  29 inches wide at reed.
                                ----
                               18792
                               4176
                               -----
     1 Hank = 840 yds.)60552(72·0857 Hanks of weft.
                       5880
                       ----
                        1752
                        1680
                        -----
                        64·076 = Hanks of twist.
                        72·058 =   Do.     weft.
                        -----
Average counts of yarn 35's)136·134(          3·8898
                        105                        4
                        ---                   ------
                        311                   3·5592
                        280                        4
                        ---                   ------
                         313                 14·2368
                         280
                         ---
                          334
                          315    3lb.  14¼ozs.  nearly.
```

The old method of "taking up" the cloth is becoming everywhere superseded by a regular motion of tooth and pinion; and which motion can be adapted to any count of cloth by the change wheels.

Required the pinion to produce cloth of 68 picks per inch, from the following particulars :

Cloth beam,	4½ inches diameter.
Do., Wheel,	82 teeth.
Double toothed Carrier Wheel,	82 ,,
And	16 ,,
Rachet Wheel	50 ,,
Do. pinion.	required.

3·1416 circumf. of a circle.
4·5 diam. of cloth beam.
157080
125664
14·13720 circumf. of cloth beam.
68
1130976
848232
961·3296
16
57679776
9613296
15381·2736 Divisor.

82 carrying wheel.
50
4100
82 = cloth beam wheel.
82
328
15381·2736)336200·0000(22 nearly.
307625472
285742280

If with the preceding wheels and pinions, cloth of 68 picks be produced, what pinion on the Rachet wheel axis will produce cloth of 88 picks?

picks. pinion. picks.
As 68 : 22 : : 88

68
22
136
136
88)1496(17 teeth pinion.
88
616
616

Required the counts of the yarn necessary to make a piece of the following description:

Length of piece	29 yards.
Width at reed	29 inches.
Count (Manchester & Stockport) reed	66 ,,
Weight of piece, 4 ℔. 4 oz., allowing	5 oz. for size.
Number of picks per inch,	72

```
lb.   oz.
3     15  = 3·943          66 }
              840          72 } Added together.
          ———————          ——
           157720          138
           31544            29 length
          ———————          ———
Divisor,  3312·120         1242
                           276
                           ————
                           4002
                             29 width at reed.
                           ————
                           36018
                           8004
                           —————
              3312·12)116058·00(35's average counts of
                      993636                yarn.
                      ———————
                      1669440
                      1656060
                      ———————
                        13380
```

Explanation of Reed Table.

1. Manchester and Stockport count by the number of ends in 1 in.

2. Bolton counts by the number of bears on 24¼ inches, 19, or 20 dents to a bear.

3. Blackburn counts by the number of bears on 45 inches, 20 dents to a bear.

4. Preston 6-4ths, counts by the number of bears on 58 inches; 20 dents to a bear.

5. Preston 9-8ths. „ „ 44 „
   20 dents to a bear.

6. Preston 4-4ths. „ „ 39 „
   20 dents to a bear.

7. Preston 7-8ths, „ „ 34 „
   20 dents to a bear.

8. Scotch and Carlisle count by the number of dents on 37 inches.

9. Nankeen counts by the number of bears on 20 inches; 19 dents to a bear.

The following Table shows at one view the number of dents in an inch, and the corresponding count of reed.

The first column contains the number of dents in 1 inch; the other columns show the counts of reed, specified at the head of each column.

By this Table it is readily ascertained what count of reed is equal to any given count, by another system of counting; for instance, a 80 reed, Manchester and Stockport count, is equal to a 90 Blackburn count.

Reed Table.

COUNTS OF REED.

No. of dents in 1 inch.	Manchester &Stockport.	Bolton.	Blackburn.	Preston. 6-4ths.
20	40	24·25	45·	58·
21	42	25·46	47·25	60·9
22	44	26·67	49·5	63·8
23	46	27·88	51·75	66·7
24	48	29·1	54·	69·6
25	50	30·31	56·25	72·5
26	52	31·52	58·5	75·4
27	54	32.73	60·75	78·3
28	56	33·95	63·	81·2
29	58	35·16	65·25	84·1
30	60	36·37	67·5	87·
31	62	37·58	69·75	89·9
32	64	38·9	72·	92·8
33	66	40·1	74·25	95·7
34	68	41·22	76·5	98·6
35	70	42·43	78·75	101·5
36	72	43·65	81·	104·4
37	74	44·86	83·25	107·3
38	76	46·07	85·5	110·2
39	78	47·28	87·75	113·1
40	80	48·5	90·	116·
41	82	49·71	92·25	118·9
42	84	50·9	94·5	121·8
43	86	52·13	96·75	124·7
44	88	53·55	99·	127·6
45	90	54·56	101·25	130·5
46	92	55·71	103.5	133·4
47	94	56·98	105·75	136·3
48	96	58·2	108·	139·2
49	98	59·41	110·25	142·1
50	100	60·62	112·5	145·
51	102	61·83	114·75	148·9
52	104	63·04	117·	151·8
53	106	64·25	119·25	154·7
54	108	65·46	121·5	157·6
55	110	66·68	123·75	159·5

Reed Table continued.

COUNTS OF REED.				
Preston. 9-8ths.	Preston. 4-4ths.	Preston. 7-8ths.	Scotch and Carlisle.	Nankeen.
44·	39·	34·	740	21·052
46·2	40·95	35·7	777	22·105
48·4	42·9	37.4	814	23·15
50·6	44·85	39·1	851	24·21
52·8	46·8	40·8	888	25·26
55·	48·75	42·5	925	26·31
57·2	50·7	44·2	962	27·36
59·4	52·65	45·9	999	28·42
61·6	54·6	47·6	1036	29·47
63·8	56·55	49·3	1073	30·52
66·	58·5	51·	1110	31·57
68·2	60·45	52·7	1147	32·63
70·4	62·4	54·4	1184	33·68
72·6	64·35	56·1	1221	34·73
74·8	66·3	57·8	1258	35·79
77·	68·25	59·5	1295	36·84
79·2	70·2	61·2	1332	37·89
81·4	72·15	62·9	1369	38·94
83·6	74·1	64·6	1406	40·00
85·8	76·05	66·3	1443	41·05
88·	78·	68·	1480	42·15
90·2	79·95	67·7	1517	43·15
92·4	81·	71·4	1554	44·21
94·1	83·85	73·1	1591	45·26
96·8	85·8	74·8	1628	46·31
99·	87·75	76·5	1665	47·36
101·2	89·7	78·2	1702	48·42
103·4	91·65	79·7	1739	49·47
105·6	93·6	81·6	1776	50·52
107·8	95·55	83·3	1813	51·57
110·	97·5	85·	1850	52·63
112·2	99·45	86·7	1887	53·67
114·4	101·4	88·4	1924	54·72
116·6	103·35	90·1	1961	55·78
118·8	105·3	91·8	1998	56·84
121·	107·25	93·5	2035	57·89

To find the Count of Reed upon any system.

If there be 23 dents in an inch, what is the count of reed by the Manchester and Stockport system of counting?

23 dents in 1 inch.
2
46 counts of reed.

If there be 28 dents to an inch, 20 dents to a bear, Bolton count, what count of reed is it?

Rule.—Multiply the number of inches set out, by the number of dents in 1 inch, and divide by the number of dents in 1 bear; the quotient will be the count of reed.

Divisor, 20 dents on a bear 24·25
28
19400
4850
2|0)67|9·00
33·95 count of reed, Bolton system.

Find what will be the count for a 9-8ths reed Preston count, 28 dents to an inch.

44 No. of inches set out by
28
352
88
2·0)123·2
61·6 count of reed Preston system.

Find the same for a 7-8ths reed Preston count.

34 No. of inches set out by
28
272
68
20·)95·2
47·6 count of reed.

What count is the same reed at Blackburn?

20 45 No. of inches on which the reed is set out.
28

360
90

2·0)126·6

63 count of reed at Blackburn.

If a reed has 29 dents in an inch, Preston 4-4ths. what count is it?

Divisor, 20 dents in a bear, 39
29

351
78

2·0)113·1

56·55

How many dents in an inch will there be in a 68 reed, 7-8ths Preston count.

Reverse the preceding *Rule.*

Multiply the count of reed by the number of dents to a bear, and divide by the number of inches set out on.

68
20

34)1360(40 dents in an inch.
136

00

Whatever count of reed you may have, the number of dents in an inch may be found in the table, if the reed come within its limits; if not, the same can be found by proportion; thus:

$$\overbrace{\text{As 72 reed : 32 dents,}}^{\text{Blackburn.}} \quad : : \quad \overbrace{\text{36 reed : 16 dents.}}^{\text{Blackburn.}}$$

Manufacturing.

The following Rules and Examples will be found useful to those who are engaged in any way with the Manufacturing department of cotton goods.

In plain work, such as the generality of Power-loom work is, the calculations, although simple, are nevertheless necessary to be known, and thoroughly understood, because of the frequent changes which are constantly occurring. In these Examples, the way to ascertain the weight or "fineness" (counts) of yarn, necessary to make any required weight or quality of cloth, will be laid down according to the various systems of counting, as shown in the Reed Table given at pages 95 & 96.

To find the weight of twist necessary for a warp.

Rule. Divide the product of the length and width (in inches) and number of ends in an inch, by the number of yards in one pound of the given counts of yarn; the quotient will be the requisite weight of yarn.

What quantity of 30's twist will be necessary to make a warp 465 yards long, 29 inches wide; 68 reed, Manchester and Stockport count.

840	465
36	29 inches width at reed.*
5040	4185
2520	930
Divisor 30240	13485
	68 ends in an inch.
	107880
	80910
	916980 Dividend.

30240)916980(30lbs. 5ozs.
90720

9780
16

58680
9780

30240)156480(5oz.
151200

---

* Note. The width of a warp is always taken in inches as it stands in the reed.

CONTINUED.

or thus: 1 lea = 12|0 yds.)91698|0

1 hank = 7 leas.)7641·6

6 1091·65

36's = 6 181·94

30·323=30lb. 5oz.

4

1292

4

5·168

What quantity of 38's twist will be required to make a warp 390 yards long. 38 inches at the reed, 72 ends in an inch?

yds. 840—1 hank.
38
6720
2520
31920

390 yds. length of warp.
38
3120
1170
14820
72
29640
103740
31920)1067040(33lb. 6¾ozs.
95760
109440
95760
13680
4
54720
4
31920)218880(6ozs.
191520
27360
4
31920)109440(3
95760

What will be the average counts of the yarn to make a piece of the following description?

Length of piece 25 yards.
Width at the reed 38 inches.
Count of reed, 72 (M. & S.)
Number of picks per inch, 88
Weight of piece (nett) 4lbs. 14ozs.

```
4lbs. 14ozs.=4.875        *26 yards, length of piece in the warp.
               840         38
              ————        ———
            195000         208
           39000          78
           ———————        ———
Divisor.   4095·000        988
                            72  count of reed.
                           ———
                          1976
                         6916
                        ——————
                         71136  yards of twist.
                             25  length of the piece when woven
                             38
                             ——
                            200
                            75
                           ————
                            950
                             88  picks in 1 inch.
                           ————
                           7600
                          7600
                         ——————
                          83600  yards of weft.
                          71136    do.  of twist.
                         ——————
No. of yds. in the )  4095)154736(37.786  average counts of yarn
given weight, at   }       12285              necessary.
1 hk. in the lb.   )       ——————
                           31886
                           28665
                           ——————
                            32210
                            28665
```

What quantity of twist will be required to make a warp of the following description, viz:—

Length of warp 148 yds.
Width at reed. 56 inches.
Count of reed (Bolton system) 30
Count of yarn 24's

*Note. One yard is allowed for weaving up, which ought always to be taken into account for the twist.

CONTINUED.

Length set out on 24·25 inches   148 yards, length of warp.
24 count of yarn.   56

9700   888
4850   740

582   8288
840 yds. in 1 hank.   30 count of reed Bolton.

23280   248640
4656   40

Divisor, 488880   )9945600(20lbs. 5½ozs. weight
977760   of twist required.

168000
4

672000
4

48888|0)268800|0(5ozs.
244440

24360
4

97440(2 nearly.

What quantity of 30's weft will be required to weave the above warp, putting 60 picks into each inch.

840 yds. in 1 hank.   148 length of piece.
30 count of weft.   56 width at reed.

25200   888
740

8288
60

25200)497280(19lbs. 15ozs. weight of weft.
25200

245280
226800

18480
4

73920

[Carried forward.

CONTINUED.

```
              73920
                  4
             ------
25200)295680(11¾ ozs.
       25200
      ------
       43680
       25200
      ------
        18480
```

What weight of twist will be necessary to make a warp of the following description, viz :—

Length of warp	260 yards.
Width at reed,	38 inches.
Count of reed, (Blackburn)	90
Count of yarn.	40's

```
  840 yards in 1 hank.            260 yards, length of warp. *
   40 count of yarn.               38 width.
 -----                           -----
 33600                           2080
    45 inches set out on.        780
 -----                           -----
 168000                          9880
1344                               90
 ------                         ------
1512|000                        889200
                                    40
                           ----------
                  1512)35568|000(23lbs. 8ozs.
                       3024
                       ----
                        5328
                        4536
                        ----
                         792
                           4
                        ----
                        3168
                           4
                        ----
                  1519)12672(8 ozs.
                       12152
                       -----
                         520
```

---

* There is no necessity to reduce the length of the warp into inches, because in that case, the hank must be reduced to inches likewise, which would give the result only, with a multiplicity of figures.

What number of ends will be required to fill 38 inches at the reed, which is 72, Manchester and Stockport count?

72 count of reed.
38 width.
576
216
2736 No. of ends in a warp.

What number of ends will it take to fill 38 inches, in a 81 reed, Blackburn count?

length, 45 set out on
38 inches, width at reed.
81 count of reed.
38
304
3078
40 ends in a bear.
45)123120(2736 ends in 38 inches.
90
331
315
162
135
270
270

What number of ends will be required to fill 38 inches in a 70 1-5th reed, 4-4ths, Preston count?

70·2 count of reed.
38
5616
2106
2667·6
40
inches, 39)106704·0(2736 ends in 4-4ths reed, 38 inches.
78
287
273

What number of inches will 2072 ends fill at the reed; the count being a 40 reed, Bolton system?

40 count of reed.	2072 No. of ends.
40 ends, or 20 dents.	24·25 inches on which 40 bears are set.
Divisor, 1600	10360
	4144
	8288
	4144

1600)50246·00(31·4 inches wide at the reed.
4800
2246
1600
6460
6400
60

What number of inches will 2694 ends fill in a 72 reed, Blackburn count?

72 count of reed.	2694 No. of ends.
40 ends, or 20 dents.	45 inches, on which 72 bears are set.
2880	13470
	10776

2880)121230(42·1 inches nearly.
11520
6030
5760
2700
2880

Rules

FOR FINDING WHEELS NECESSARY TO PRODUCE ANY GIVEN DRAUGHT.

1st.—To find wheels necessary to produce any draught required between the back and front rollers on the mule.

Rule 1.—Assume two numbers convenient for the back roller wheel, and change pinion; divide the given draught by their ratio, which quotient will be the ratio of the two wheels (front roller, and top carrier, or crown wheel). Multiply the diameter of front roller by any number; and the diameter of the back roller by the same number, and also by the ratio last named; the resulting numbers will be the driver and the driven wheels.

Ex. 1. Suppose the front roller to be one inch. and the back roller 7-8ths of an inch diam.; what wheels and pinions will be required to produce a draught of 10.

Assume } 48 back roller wheel,
} 24 change pinion. Therefore ratio = 2

2) 10 = draught.

—

5 = ratio of front roller wheel and cr. wheel.

diam. of front 8 7 diam. of back roller.
3 3

— —

24 front rol. whl. 21
5

—

105 large crown wheel.

Ex. 2. Find the draught of the mule from the following data, viz:—

Front roller wheel	24	teeth.	driving.
Large Crown ,,	105	,,	
Change pinion	24	,,	driving.
Back roller wheel	48	,,	

Diam. of front roller 1 inch, or 8.
Diam. of back 7-8ths. ,, ,, 7.

24 105
24 48

— —

96 840
48 420

— —

[*Carried forward.*

CONTINUED.

576 5040
7 8

Divisor, 4032)40320(10 draught.
4032

00

Ex. 3. With the data in Ex. 1st; but assuming the back roller wheel 42, and change pinion 30; what wheels will be necessary to produce the same draught?

Back roller, 42
— =7-5ths, ratio.
Change 30

and 10 divided by 7-5ths, =50-7ths, ratio of front roller wheel and crown wheel.

Diam. of front roller 8 diam of back, 7 × 50-7ths, × 2 = 100 cr. wheel,
2

Front roller wheel 16

Proof

16 100
30 42

480 4200
7 8

Divisor, 3360)33600(10 draught.
3360

00

The same rule will also apply to the roller draught of Drawing Frames, Slubbing or Jack Frames.

Suppose the front roller of a Slubbing Frame be $1\frac{1}{4}$ inch. diam. the back 1 inch, and the draught 6.2, what wheels and pinions are required to produce it?

Back roller wheel, 44
— = 2, their ratio.
Change pinion, 22
2)6·2 whole draught.
3·1 = ratio of front roller.

eighths. eighths.
Diam. of front rol. 10 8 diam. of back rol.
2 2

Front rol. wheel 20 16
3·1

48 stud wheel.

Rule 2.—Reduce the diameters of the front and back rollers to eighths of an inch; and multiply the latter by 8 for the back roller wheel, and likewise the former by 4 for the change pinion. Next suppose a pinion for the front roller, which being multiplied by half the draught will give the stud wheel.

Ex. Suppose the front be 1 1-8th inch, and the back 1 inch diameter; the pinion on front rollers 20; what wheel and pinions will be necessary for a draught of 8?

	eighths.	eighths.	
Diam. of front rol.	9	8	diam. of back rol.
	4	8	
Change pinion.	36	64	back rol. wheel.

20 pinion on front roller.
4 = half the draught.
80 = Stud Wheel

To find wheels necessary to produce a given number of revolutions; having the pinions given.

Rule 3.—Find the *product* of all the pinions, and number of revolutions, which product must be divided by as many *numbers* as will do so, and leave no remainder; then place the *numbers* in a line, and arrange them in groups; the product of each group of *numbers* will be the number of teeth in the respective wheels.

Ex. Suppose the cloth beam of a loom is required to make 1 revolution, while the loom make 1000 picks; what number of teeth must each of three wheels contain, respectively; viz:—the Racket wheel, the Stud wheel, and Cloth beam wheel; the intermediate pinions being 19 and 16.

19
16 Pinions.

114
19

304
1000 revols. of Crank shaft working Racket wheel.

Divisors, 10)304000(

5)30400

[*Carried forward.*

CONTINUED.

5)530400
10)6080
8)608
4)76
19)19
1

$\overbrace{10 \;:\; 5;}$	$\overbrace{10 \;:\; 8;}$	$\overbrace{4 \;:\; 19;}$
Racket wheel.	Stud wheel.	Cl. B. when.
50	80	76

The divisors may be arranged at pleasure, to suit the convenience of various plans.

Miscellaneous Calculations,

TABLES, Etc.

To find the Hank, or proportion of an Hank at the end of any operation.

Rule. The product of all the draughts, and length fed on feed cloth at Lap Machine, divided by the product of the doublings, the weight and length of 1 Hank will give the Hanks in a pound, or decimal of an Hank.

Ex. 1. Suppose 20 ozs. of cotton be spread on 36 inches at the Lap Machine; draught of do. 2; draught of Breaker Card, 72; what is the size of the carding?

```
1 Hank = 840 yds.        72 draught at carding.
20 ozs. =   1¼            2    do.   at Lap Machine.
          ----           --
           840     1050)144·0(·13714, rather more than 1·8th of
       ¼ = 210           1050             an hank in the lb.
          ----           ----
          1050            3900
                          3150
                          ----
                           7500
                           7350
                           ----
                            1500
                            1050
                            ----
                            ·4500
                             4200
                             ----
                              300
```

Ex. 2. Suppose 16 ozs. are spread on 30 inches; draught of Lap Machine, 2; Breaker Card, 70; Finisher, 140; Doublings at Lap Machine, 68; what proportion of an hank is the carding?

```
              840 yds.           140 draught at Breaker Card.
Doublings = 68                    70   do.   at Breaker.
            ----                 -----
            6720                  9800
           5040                      2   do.   at Lap Machine.
           -----                 -----
           57120                 19600
1 yd. =       36 inches.            30 inches.
          ------                 -----
          342720  2056320)588000·0(·2859477, or rather more than
         171360          4112640                  ¼ Hank in the lb.
         -------         --------
Divis.   2056320         17673600
                         16450560               [Carried forward.
```

CONTINUED.

```
12230400
10281600
--------
  19488000
  18500880
  --------
    9811200
    8225280
    -------
     15859200
```

To find the weight of cotton to produce a given count.

Ex. 3. What weight of cotton must be spread on 36 inches at the Lap Machine, to produce ½ Hank slubbing, (making no allowance for loss) the draughts and doublings being as follows: Lap Machine 2, Breaker Card 72, Finisher Card 140, Drawing Frame 6·6 at each of three heads, Slubbing Frame 6; Doublings. Lap Machine 68, Drawing Frames 6 at each head; Slubbing Frame 3.

```
     72  draught of breaker card.
      2     do.     Lap Machine.
     --
    144
     140  do.   at Finisher Card.
     ---
     5760
    144
    -----
    20160
      6·6   do.   1st Head of drawing.
    -----
    120960
   120960
   ------
   133056·0
      6·6          do.   2nd       do.
   --------
    798336
   798336
   ------
  878169·6
      6·6        do.   3rd      do.
  --------
  52690176
 52690176
 --------
```

[Carried forward.

CONTINUED.

5795919·36
6 do. Slubbing Frame.

Dividend, 34775516·16 Total of draughts.

68 Doublings at Lap Machine.
6 do. ,, 1st Head of Drawing.

408
6 do. ,, 2nd do.

2448
6 do. ,, 3rd do.

14688
3 do. ,, Slubbing Frame.

Divisor, 44064 Total Doublings.
44064)34775516·16(789·2 yds. of ½ hank Slubbing.
308448

393071
352512

405596
396576

yds.
840 = 1 Hank.
420 = ½ ,,

90201
88128

2073

If 420 yards of Slubbing weigh 1lb., what will 789·2 yds. weigh?

yds. : ozs. : : yds.
420 : 16 : : 789·2

789·2
4

3156·8
4

420)12627·2(30·06 ozs. to be spread on 36 inches at Lap Machine.
1260

2720
2520

200

Ex. 4. Required the quantity of carding delivered by each Engine in 9 hours successive working; from the data given under the head "Carding Engine."

```
                           3·1416 circumf. of a circle.
                               17 diam. of doff. cylinder.
                           ------
                           219912
                           31416
                           ------
                          53·4072 = circumf. of doff. cylinder.
                             5·83 = revols. of do. per minute.
                          -------
                          1602216
                         4272576
                        2670360
                        ---------
Doff. Cyl. traverses  311·363976  inches per min.
                              60
                      ------------
       1 ft. 12 in.)18681·838560
                    -------------
                     1556·81988 = feet per hour.
                              9
                    -------------
                    14011·37892 = feet per day.
```

Ex. 5. Required the weight of the Lap at the Carding Engine, for spinning 20's twist; the weight for 34's having been 10 ozs. per 36 inches. The roller draught in the case of 34's having been 9, and for 20's, to be 7.

```
            counts.          counts.          ozs.
Divisors, { 20's              34's             10
          {   9 drgt.           7 drgt.
             20                34
              9                 7
             --                --
            180               238
                               10
                    18|0)238|0(13·22  ozs. weight of Lap.
                         18
                         --
                          58
                          54
                          --
                           40
                           36
                           --
```

Ex. 6. Required the counts of the rovings, when 30 yds. weigh 62·5 grs.

grs.
62.5
840 yds.=1 hank.

25000
5000

52500·0

grs.
7000=1℔.
30 yds.

52500)210000(4 hanks in the ℔.
210000

The following is an abbreviated method of working this and similar questions.

62·5)250·0(4 hanks in the ℔.
2500

Explanation.—30 yards is ¼ of a lea, or 1-28th of an Hank: therefore, if we take 1-28th part of 1 lb., or 7000 grs., we shall get 250 grs.; this number being divided by the weight of 30 yards, will give the counts.

TABLE 1.

Inches.	Dividends.	Inches.	Dividends.	Yarns.	Dividends.
1	·23148	19	4·39812	1	8·3333
2	·46296	20	4·62960	2	16·6666
3	·69444	21	4·86108	3	25·
4	·92592	22	5·09256	4	33·333
5	1·15740	23	5·32404	5	41·666
6	1·38888	24	5·55555	6	50·
7	1·62036	25	5·78700	7	58·333
8	1·85184	26	6·01848	8	66·666
9	2·08332	27	6·24996	9	75·
10	2·3148	28	6·48144	10	83·333
11	2·54628	29	6·71292	12	100·
12	2·77777	30	6·94444	15	125·
13	3·00924	31	7·17588	20	166·
14	3·24072	32	7·40736	30	250·
15	3·4724	33	7·63884	40	333·333
16	3·70368	34	7·87032	60	500·
17	3·93516	35	8·10180	80	666·666
18	4·16666	36	8·33330	120	1000·

The Table may be extended to suit the convenience of every one. The following is the method of obtaining the dividends. Some of them are aliquot parts of 7000 grains; others are not so, and are therefore carried out decimally.

Ex. 7. Required the dividend for 30 inches.

	inches.		grs.		inches.
As	30240*	:	7000	: :	30
			30		

30240)210000(6·944
181440
285600
272160
134400
120960
13440

Ex. 8 Required the dividend for 80 yards?

	yds.		grs.		yds.
As	840	:	7000	: :	80
			80		

840)560000(666·6 grs.
5040
5600
5040
5600
5040
5600
5040
560

Ex. 9 If 36 inches of slubbing weigh 16·6 grs., what counts is it?

The dividend for 36 inches, or 1 yard, is 8·333.
Therefore 16·66)8·333(·5, or ½ Hank.
8330
3

Ex. 10. If 1 lea of yarn weigh 25 grs., what Hank will it be?

25)1000(40 Hank in the lb.
100
00

Hence, in wrapping yarn, as many leas, or wraps as you weigh, take so many thousands for your dividend.

*Inches in 1 Hank.

TABLE 2.

Leas.	Dividends.
1	1000
2	2000
3	3000
4	4000
5	5000
6	6000
7	7000

The two preceding tables may also be used for finding the *weight* of any given length of Lap, Drawing, Roving, or Yarn, from the counts.

Divide any one of the dividends by the known counts of any Yarn, Roving, &c., and the quotient will be the weight of the length, which is opposite to it in the table.

Ex. 11. What is the weight of 30 yards, and also of 420 yards of 4 Hank roving? (See Example 6th, page 114.)

Dividend.
4·4) 250
——
62·5 grs. wt. of 30 yds.

Dividend.
3000=3 leas.
500=½ „
——
4)3500=3½ leas, or 420 yds.
——
875=2 ozs.

Ex. 12. What is the weight of 420 yds. of ½ Hank Slubbing?
½ Hank= ·5)3500·=3½ leas, or 420 yds.
——
7000=1 lb., weight of 420 yds.

Ex. 13. What is the weight of 1 lea, 36's yarn?
grs.
36)1000(27·777 weight of lea.
72
—
280
252
——
280
252
——
28

The preceding examples may serve to show the method of forming Tables of the weight of Drawing, Roving, or Yarn, which are useful to the Overlooker, and others, for readily ascertaining the counts.

Note.—The following table is given as a specimen, rather than as an useful table, because, one sufficiently extensive to answer the purposes of all parties, would be too large for ready reference; and as tables can easily be made at leisure, precisely adapted to the department for which they are required, it has been thought proper to give one as a specimen, which may be extended for more easy reference.

ROVING AND YARN TABLE.

FOR 30 YDS.			FOR 1 LEA, OR 120 YARDS.					
Hank.	dwt.	grs.	Hank.	dwts	grs.	Hank.	dwts	grs.
·25	41	16·0	20	2	2·00	46	0	21·739
·50	20	20·0	21	1	23·61	47	0	21·237
·60	17	8·6	22	1	21·45	48	0	20·833
·70	14	21·0	23	1	19·47	49	0	20·408
·80	13	0·5	24	1	17·66	50	0	20·000
·90	11	13·7	25	1	16·00	51	0	19·607
·95	10	23·0	26	1	14·46	52	0	19·230
1.00	10	10·0	27	1	13·03	53	0	18·867
1·20	8	16·3	28	1	11·71	54	0	18·518
1·25	8	8·0	29	1	10·48	55	0	18·181
1·30	8	0·3	30	1	9·33	56	0	17·857
1·40	7	10·8	31	1	8·25	57	0	17·544
1·50	6	22·6	32	1	7·22	58	0	17·241
2·00	5	5·0	33	1	6·30	59	0	16·949
2·25	4	14·9	34	1	5·70	60	0	16·666
2·50	4	4·9	35	1	4·28	61	0	16·393
2·75	3	18·9	66	1	3·77	62	0	16·129
3·00	3	11·3	37	1	3·30	63	0	15 874
3·25	3	4·9	38	1	2·31	64	0	15·625
3·50	2	23·4	39	1	1·64	65	0	15·384
3·75	2	18·6	40	1	1·00	66	0	15·151
4·00	2	14·5	41	1	0·39	67	0	14·925
4·25	2	10·8	42	0	23·71	68	0	14·705
4·50	2	7·7	43	0	23·25	69	0	14·492
4.75	2	6 7	44	0	22·72	70	0	14·285
5·00	2	2·0	45	0	22·22	71	0	14·084

If a set of cops contain 1260 Hanks, what should be the weight, the counts being 36's?

Hanks.
36)1260(35 lbs. weight of set.
108
———
180
180

If a pair of mules be spinning 4 hank roving, the set of cops weighing 35 lbs.; length put on, 13 5-8ths leas, or wraps; number of spindles, 648; required the draught of the mules.

```
                 lbs.              spindles.
weight = 35                         648
              4 Hank.                13 5-8ths.
             ——                    ———
           140                     1944
              7 leas = 1 Hk.       648
          ———                       405 = 5-8ths.
           980                     ———
                            980)8829(9, draught of the mule.
                                8820
                                ———
                                   9
```

If a set of cops weigh 42 lbs., number of spindles, 649 ; length put on, 13 5-8ths leas ; what are the counts of yarn?

```
                 lbs.                      spindles.
Weight of set 42                            648
leas in 1 Hk.=7                              13 5-8ths
             ——                            ———
            294                            1944
                                           648
                                            405=5-8ths.
                                           ———
                                    294)8829(30's counts of yarn.
                                        882
                                        ———
                                           9
```

If a pair of mules contain 792 spindles, and puts 652 stretches on each set; each stretch measuring 60 inches; what will be the weight, if the Nos. spinning be 38's?

```
                                  spindles.
         840                        792
          36=1 yd.                   650 stretches.
         ———                        ———
         5040                       396000
        2520                        4752
        ———                         ———
        30240                       514800
          38's                              60 length of stretch.
        ———                         ———
        241920     1149120)30888000(26 lbs. 14 ozs., weight
        90720              2298240        of set of cops.
        ———                ———
       1149120              7905600
                            6894720
                            ———
                            1010880
                                 16=oz.
                            ———
                            6065280          [Carried forward.
```

CONTINUED.

6065280
1010880

1149120)16174080(14 ozs.
1149120

4682880
4593480

86400

If a mule be spinning 5 hank roving, 55 inches being delivered from the rollers, and the whole length of stretch being 60 inches, what roller draught will be required to spin 40's?

		counts.
Length of stretch=60		40's
Hank roving	5	55=inches delivered from rol.
	300	3|00)22|00

7⅓ draught required.

How many hanks will there be in a set of cops of the following description?

No. of spindles 1719
No. of Stretches 1152
Length of do. 60 inches.

yds.	
840=1 Hank.	1719 No. of spindles.
6	1152
5040	3438
6	8595
	1719
30240 inches.	1719

1980288
60 length of stretch.

30240)118817280(3929 Hanks.
90720

280972
272160

88128
60480

[Carried forward.

Continued.

276480
272160

4320
7

30240)30240(1 lea.
30240

If a warp containing four cuts be 120 yds. long, and having 2000 ends of 40's twist, what will be the weight of 1 cut?

yds.
840=1 Hk.
40 Hks.=1 lb.

33600

ends.
2000
120

336|00)2400|00(7 lbs. 2½ ozs.
2352 weight of 4 cuts.

48
4

192
4
} =16

336)768(2¼ ozs.
672

96
4

336)384(1
336

48

lbs. ozs.
4) 7 2½

1 12½ wt. of 1 cut.

A warp 60 yards long, is to be made from 5 lbs. 8 ozs. of 50 hank twist, required the number of ends.

yds.
Divisor 60

Hanks.
50=1 lb.
5½ lbs.

250
25=½ lb.

275
840 yds.=1 Hank.

11000
2200

[*Carried forward*

CONTINUED.

6|0)23100|0(

3850 = Number of ends.

NOTE.—The two preceding questions are worked in another way, for the purpose of showing other applications of Table 1, at page 114. By that table, the weight of a single thread, or end, may be ascertained with ease, of any length whatever: this being known, the weight of any given length, or the length of any given weight may be found by proportion.

Thus: 500 is the dividend for 60 yards; and 500 divided by 50; thus:

$$\frac{500 \text{ grs.}}{50} = 10 \text{ grs.}$$

grs.
7000 = 1 lb.
5½
35000
3500 = ½ lb.
1|0)3850|0(
3850 = number of ends.

NOTE.—The weight of 60 yards, of 50 hank twist, is 10 grs; and 5½ lbs. reduced to grs., and divided by that, gives the number of ends; which in other words, is nothing more than the length of 5½ lbs. of 50 Hank yarn, as if it were a single thread.

Again: In the example preceding the last, the dividend for 1 lea is 1000: this divided by 40, gives 25 grs. the weight of 120 yards of 40's yarn.

Therefore grs. 25
2000
1 lb. = 7|000)50|000
7·143 = 7 lbs., 2¼ ozs., weight of 4 cuts.
4
·572
4
2·288

A warp containing 8 Cuts, of 30 yards each, is to be wove with 34's weft: the width of warp in the reed is 29 inches: the count of reed 72 (Manchester and Stockport), and 80 picks per inch. Required the weight of weft necessary for the whole; and also the weight of each Cut when wove, the twist being 32's.

$$\frac{240\times36\times29\times80}{840\times36\times34} = \frac{20044800}{1028160}$$ this divided by

gives 19 lbs. 7 ozs. 14 drs. weight of weft required.

Again: For the twist.

$$\frac{240\times36\times29\times72}{840\times36\times32}=\frac{18040320}{967680}=\begin{array}{ccc}\text{lbs.}&\text{ozs.}&\text{dr.}\\18&10&4\end{array}$$

	lbs.	ozs.	drs.	
	19	7	14	weft.
	18	10	4	twist.
8)	38	2	2	
	4	12	4	weight of 1 Cut.

If 2 lbs. 8 ozs. of 40 Hank weft be put in a Cut of 28 yards; the warp to stand 30 inches in the reed; how many picks per inch will there be in the cloth?

$$\frac{840\times2\tfrac{1}{2}\times40}{28\times30}=\frac{84000}{840}=100 \text{ picks per inch.}$$

If a warp made from 20 Hank twist, 420 yards long, and containing 2000 ends, be sold for £1 17s. 6d., what is the price of the yarn per lb?

$$\frac{840\times20\times450\cdot\text{d}}{420 \text{ yds.}\times2000}=\frac{7560000}{840000}=9\text{d. per lb.}$$

INDICATORS.

The following calculations relate to a new kind of Indicator, well adapted to various parts of machinery in a mill. It is neat in appearance, and constructed in such a manner as to work a considerable period of time with very little trouble or attention, except that of oiling. The one I shall first describe, is applicable to Bobbin or Slubbing Frames.

The dial plate is marked Hanks and Decimal Hanks, having one hundred in the circumference. The case is a circular box of metal of sufficient size to contain the wheels which are enumerated below.

A wheel of	12	teeth	driving
Do.	30	,,	on the axis of which is
a pinion	10	,,	driving
a wheel	40	,,	on the axis of which is
a pinion	6	,,	driving
a wheel	60	,,	carrying the hand which indicates Decimal Hanks.

This last

pinion of 6 teeth, also drives another
wheel of 60 ,, on which is
a pinion of 6 ,, driving
a wheel 60 ,, carrying the hand which indicates hanks.

From the above data, it will be seen that the hand which shows "Decimal Hanks," makes one hundred revolutions while the other makes one.

Thus 6 pinion. 60 wheel.
6 60
— 36)3600
36 ——
100

Find how many revolutions the first wheel (12) makes for the last one, from the preceding data.

Drivers 12 30 Driven.
10 40
— ——
120 1200
6 60
—— ——
72|0 72|0)7200|0
—— ——
100 revols. of 1st wheel

There is on the same axis with the first wheel (12) another wheel, driven by a worm on the front roller; this arrangement is necessary in order that the Indicator may be applicable to various sizes of rollers.

Now suppose the front roller of a "fly frame" be 1¼th in. diam. what wheel must be put in connexion with the worm on the front roller, so that one space by the small Hand, or 100 spaces (one revolution) by the long Hand may indicate one Hank?

Solution 3·1416 cir. of circle 840 yards in 1 hank
1·25 dia. of rol. 6
—— ——
157080 5040
376992 6
—— ——
3·927000 30240 inches in hank.
100 revols. of 1st wheel. ——
—— ——
392·7 392·7)30240·0(77 wheel required.
27489
——
27510
27489
21

Suppose the front roller to be 1 inch diameter, what size of wheel must be put on, to indicate one hank given out by the rollers?

3·1416 circum. of roller.
100 revols. of 1st wheel for index one.

314·16
314·16)30240·00(96 wheel required.
282744

196560
188496

8064

There is another arrangement differing a little from the preceding, and which is very suitable for warping mills; this is driven by the middle stretching roller. The wheels, &c., are as follow:

	wheel.		
A worm driving	20		on the other end
a worm driving	20		on the same axis
a pinion of	10		driving
a wheel of	42		which carries the decimal hand on the dial
a pinion of	6	teeth	driving
a wheel of	60	,,	on which is
a pinion of	6	,,	driving
a wheel of	60	,,	which carries the smaller hand.

Find how many revolutions the first worm, or in other terms, the roller makes for the decimal hand one.

Thus, 10 pinion 20 first wheel.
20

400
42

1|0)1680|0

1680 revolutions of roller for one of decimal hand.

It is evident that if the stretching roller be 18 inches in circumference, the decimal hand will indicate one hank for every revolution.

18 in — ½ yard 2)1680 revolutions.

840 = 1 hank.

or thus 1680
18

[*Carried forward.*

CONTINUED.

13440
1680
6) 30240 inches in 1 Hank.
6) 5040
840

The indicator sent out with "Kenworthy's Patent Warping Frames," at least the first portion of them, were marked simply with "cent." on the dial, having 40 in the circumference. The wheels are as follow:

		wheel.	
A worm into		30	on the same axis.
a worm	,,	80	,, ,,
a pinion	of	7 teeth	driving
a wheel	of	70	on same axis.
a pinion	of	7	driving
a wheel	of	70	carrying the index.

How many revolutions will the first worm, or the roller make for the last wheel, or index one?

		wheel.
	7 pinion	30
	7 ,,	80
Divisor	49	2400
		70
		168000
		70

49)11760000(240·000 revols. of roller for index one.
98
196
196
00000

How many Hanks or leas are there in one revolution of the index, supposing the roller to be 18 inches in circumference?

Divide by 2)240·000
1 lea = 12|0yd)12000|0 = yards.
1000 = leas.

How many Hanks are there in 40 cents., and also in 1 cent. of the Indicator, with 340 ends in the warp?

7)1000 = 40 cents.
$142\frac{6}{7}$ hanks.
340 ends.
5680
426
291
48571 hanks in 40 cents.

4|0)100|0
7) 25
3·57 hanks in 1 cent.

3·57
340 ends in a warp.
14280
1071
1213·80
40
48552·00

What is the weight of a warp or beam, having 3 cents by the Indicator, and containing 259 ends of 36's twist?

3·57
3
10·71
259
9639
5355
2142
6)2773·89
6)462·31
77· lbs. weight of beam.

What weight of work has been done by a Fly Frame in one day, the Indicator showing 7 Hanks given out by the rollers, the frame having 72 spindles, 4 Hank roving?

72 spindles.
7
4)504
126 lbs.

Suppose the diameter of the front roller to be $1\frac{1}{8}$th inch, what size of wheel must be put on to indicate one hank given out by the rollers?

3·1416 Circum.
1·125 = $1\frac{1}{8}$
157080
62832
345576
3·5343000
100
353·43

840
6
5040
6
353·43)30240·0(85·5
282744
196560
176715
198450
176715
21735

Cotton.

The "COTTON TREE" has been looked upon as being emblematical of wealth and industry. And certainly its production has been the source of wealth and prosperity to an almost unknown extent. The enormous quantity of Cotton imported into this country cannot but excite some curiosity concerning its cultivation and growth. It may therefore be presumed that a short description of the Cotton Plant and its mode of cultivation may not be unacceptable to the class of readers for whom this work is more particularly intended, viz :—those who have not the advantage of reference to more extensive works.

Some Botanists enumerate ten species of the Cotton Plant, which are distinguishable by the form of the leaf and the size of the tree. Dr. Royle, in a paper read before the British Association in 1842, states that he "formerly believed the number of species to be eight; but more careful enquiry had induced him to reduce the number to four, and to regard the others as merely varieties. Two of these four species are natives of India:—1st. The common herbaceous Cotton, which produces the Cotton-Wool imported into this country from India. 2nd. The Tree Cotton with red flowers. The two other species are American; these are, 1st. The Peruvian Cotton, which yields the Brazil, Pernambuco, Bahia, &c., Cottons. It differs from the other species in bearing its seeds in clusters. 2nd. The Barbadoes Cotton, which takes its name from its having been early cultivated in Barbadoes; but is believed to be a native of Mexico. It is the same as the Upland and Sea Island Cotton of the United States; and the Egyptian, Barbadian, and Bourbon Cottons have all been derived from it by differences of soil, climate, and cultivation. These appear to be all the Commercial

Cottons: there may be other species in Africa and China, but there is a want of evidence in support of the fact." Dr. Royle goes on to say, "With reference to qualities of Cotton, he believes it to be indisputable that the American Cotton greatly excels that of India; but he thinks the difference is owing to the more skilful culture bestowed upon the plant in America than to any superiority in the Cotton itself. In America the cultivation of a Cotton field is conducted on the plan of a garden; while in India, Cotton is subjected to common field culture. In America great care is exercised in the gathering of the Cotton as soon as it is ripe, and before the leaf growing close under the pod, becomes withered and friable, so as to mix with the Cotton. In all which, the process in India differed materially."

"The mode of cultivating the Cotton Plant depends upon its being *Annual* or *Perennial.* In general the annual Cotton Tree thrives best in a dry gravelly soil; it is said to answer better in old than newly cultivated lands. The Planters generally commence preparing their lands in February, and put in the seeds during March and April, and the Cotton is gathered by hand, in a few days after the opening of the *pods*, in August, September, and October." Of course this applies to the common *herbaceous* Cotton. "In America it is planted in rows five feet asunder, and in holes eighteen inches apart, in each of which, seeds are deposited; careful weeding of the ground is necessary, and the plants require to be gradually thinned, so as ultimately to leave only one or two for each hole; they are also pruned twice, by nipping off the end of the branches, in order to make them put out more branches, and yield a larger quantity of blossom and fruit. When the flower falls off, a capsular pod appears, supported by three triangular green leaves, deeply jagged at their ends; the pod approaches to the triangular shape, with a pointed end, and has three cells. It increases to the size of a large filbert, and becomes brown as the woolly fruit ripens; the expansion of the wool then causes the pod to burst, when it discloses a ball of snow-white or yellowish down, consisting of three locks, one in each cell, enclosing and firmly adhering to the seeds, which in form resemble those of grapes, but are much larger.

"The *Shrub Cotton* grows in almost every country where the annual herbaceous Cotton is found. Its duration varies according to the climate; in some places as the West Indies, it is biennial or triennial; in others as India, Egypt, &c., it lasts from six to ten years; in the hotest countries it is perennial; and in cooler countries which grow Cotton, it becomes an annual. In appearance, the Shrub has a considerable resemblance to the currant bush. The flower and fruit of the Shrub-cotton closely resemble those of the herbaceous, but the pod is egg-shaped, not triangular and pointed. It is found in one or other of its varieties throughout the tropical countries of Asia, Africa, and America. The Shrub is planted in holes from seven to eight feet apart; eight or ten seeds are put in each hole, but only one of the stems is allowed to remain; they require to be pruned and the ground carefully weeded; and seldom continue to produce good Cotton more than six years; but in the hotest countries two crops are gathered, one from October to December, and the other from February to April. The Guiana and Brazil Cottons are of this kind.'

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